Volume 37 Number 9 September 1975

Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service

Gulf

MENHADEN FISHERIES

Atlantic

U.S. DEPARTMENT OF COMMERCE
Rogers C. B. Morton, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

Address correspondence to: Marine Fisheries Review, NMFS Scientific Publications Staff, Room 450, 1107 N.E. 45th St., Seattle, WA 98105.

Publication of material from sources outside the Service is not an endorsement. The Service is not responsible for the accuracy of facts, views, or opinions of these sources.

Although the contents have not been copyrighted and may be reprinted freely, reference to source is appreciated.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, through May 31,1975

Managing Editor: Willis L. Hobart

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.10 (single copy). Subscription price: $12.75 a year, $15.95 a year for foreign mailing.

Marine Fisheries Review

Vol. 37, No. 9
September 1975

CONTENTS

Articles

1 Status of the Gulf and Atlantic Menhaden Fisheries and Implications for Resource Management, William E. Schaaf

10 Some Observations of Feeding Behavior of Bottle-Nosed Dolphins (*Tursiops truncatus*) in the Northern Gulf of Mexico and (*Tursiops* cf *T. gilli*) off Southern California, Baja California, and Nayarit, Mexico, Stephen Leatherwood

17 Laboratory Evaluation of a Denil-Type Steeppass Fishway with Various Entrance and Exit Conditions for Passage of Adult Salmonids and American Shad, Emil Slatick

27 Night Stalking Flounder in the Ocean Surf, Stanley M. Warlen

Departments

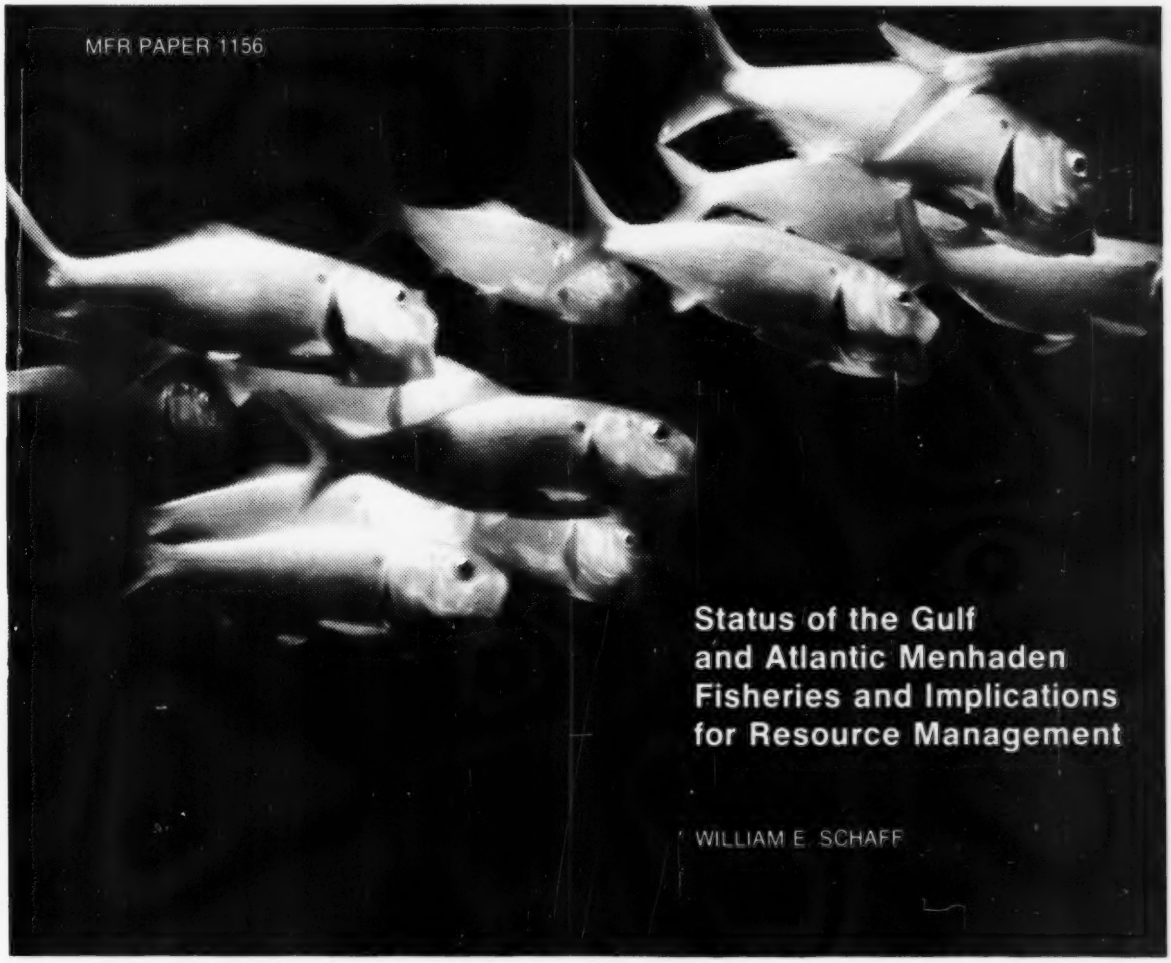
31 NOAA/NMFS Developments

35 Foreign Fishery Developments

38 Publications

40 In Brief. . . .

MFR PAPER 1156



Status of the Gulf and Atlantic Menhaden Fisheries and Implications for Resource Management

WILLIAM E. SCHAFF

ABSTRACT—The history and status of federal biological studies of Atlantic menhaden, Brevoortia tyrannus, *and Gulf menhaden,* B. patronus, *are discussed in relation to fisheries management. The historical development of the two fisheries indicates 1) the dangers of overfishing, 2) the positive effects of reducing effort in an overexploited fishery, and 3) the potential benefits of limiting effort in a productive fishery. Several issues crucial to developing specific management plans are discussed according to biological principles. This leads to a concept of management that requires fishery models that can specify alternative plans. Implicit with this concept is a willingness to adopt minimal management that can be implemented soon and is flexible. Models of the two menhaden fisheries are presented to support implementation of initial catch quotas before limiting effort. Both fisheries offer a favorable opportunity for establishing a management plan for wise utilization of resources. The ideas presented here are to direct attention to the need for management and to serve as guides toward management alternatives.*

INTRODUCTION

At a time when there is much discussion regarding the management of our Atlantic and Gulf menhaden fisheries it seems necessary and appropriate to discuss, as concisely as possible, the need for management, the status of the stocks and the data base for such assessment, historical precedents for management, and some key management issues. The issues discussed in this paper are not exhaustive but are considered to be of primary importance from a restricted point of view.

The purpose of the paper is to summarize our knowledge of the menhaden fisheries; the problems, as we view them; some tentative solutions based upon a traditional biological view; and to indicate problem areas which preclude a complete or optimal management plan. It is intended as a prototype for the interdisciplinary dialogue which will be necessary to achieve wise utilization of one of our great natural resources.

The scope of this issue paper will be confined to a rather traditional biologist's view of the resource and its response to harvesting at various levels of intensity, particularly the total

William E. Schaaf is with the Atlantic Estuarine Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, NC 28516

yield and the yield per unit of fishing effort. Those issues dealing with biological management will be discussed in greater detail, while issues dealing with the economics of the industry, social values, or political institutions will be mentioned where appropriate, but not dealt with specifically.

The needs for management will be demonstrated more fully when dealing with the historical trends in catch and effort for each fishery and with the models and deductions from biological data, but some introductory remarks may put the needs in perspective. First is the expressed desire for management, by some segments of the industry. The current industry attitude appears to seek a management plan that will involve cooperation between States, Federal agencies, and the industry, a concept we endorse. There is some anxiety in industry about possible new investment, overcapitalization, and eventual resource depletion. Some industry representatives have actively worked toward establishing a management subcommittee of the Gulf States Marine Fisheries Commission (GSMFC) that can formulate and propose regulations. Fishery biologists consulting for industry also endorse management. Secondly, the history of landings in both fisheries demonstrates the benefits to be gained by regulating fishing effort at a level which will produce the maximum sustainable value. Many people feel that the Gulf fishery is near its peak, and they would rather restrict it now than suffer a collapse similar to the Atlantic. Finally, we have many precedents among marine fisheries that have declined. Unfortunately, most examples are of fisheries that have not been managed at all, with attendant economic extinction. The great Pacific sardine reduction fishery is a good example. The extensive experience with the North Sea trawl fishery for many species, its depletion, rehabilitation with reduced effort during the war, and subsequent depletion again, led Michael Graham (1949) to state the Great Law of Fishing:

> "So, even the fisheries that have never seemed to be troubled by 'depletion' take their place beside the overfished ones; they are only saved by their limited market, which prevents free fishing, thus saving the fishery by imposing a limit, just as the overfished ones could be saved by only fishing up to a limit. If there is no other limit, Nature will impose one: the limitation of unprofitableness.
>
> "The Great Law of Fishing can be stated in a few words: 'Fisheries that are unlimited become unprofitable.' "

Purse boats beginning a set on a 70-ton school of menhaden. (Photograph by Hall Watters, Standard Products Co., Southport, N.C.)

In spite of much experience which lends credence to the Great Law, we should not have blind faith in a converse law, that limiting effort will restore profit to a fishery, although here again we have some experience indicating this to be true. Fishery management, per se, and as usually practiced, is rarely a panacea for either the resource, consumer, or the industry. Fisheries under management have collapsed, or at least become unprofitable. What we do have is a belief that doing something—if we do it cautiously—is better than doing nothing. What we need is courage to try uncontrolled experiments and wisdom to be flexible in our planning.

HISTORY AND PURPOSE OF FEDERAL BIOLOGICAL STUDIES

Interest in menhaden as a national resource was stimulated after World War II by the increased use of fish meal for feed supplements and for export, and the decline of the Pacific sardine fishery. During 1952-54 most of the plant owners and managers of the Atlantic coast menhaden industry

were convinced that a scientific investigation of the resource would benefit them by determining the biological characteristics and population structure of menhaden. In 1955 an investigation of Atlantic menhaden was undertaken with the primary objectives of determining the causes of natural fluctuations in abundance and the extent to which these fluctuations were predictable. The program was an extension of preliminary studies conducted in the middle Atlantic area since 1952. By 1959 some characteristics of the fishery were known: 1) fluctuations in abundance resulted principally from variations in year-class strength, determined after the year-class entered the fishery; 2) estuaries are nurseries and their preservation and maintenance are essential to the menhaden resource; and 3) juvenile abundance in estuaries could provide estimates of year-class strength before recruitment into the fishery. Also, by 1959 it was the provisional conclusion that the Atlantic menhaden resource was being overexploited. Industry action with National Marine Fisheries Service (NMFS) support was able to get Congressional additions to the budget annually from 1964 to 1969. Extensive tagging studies, increased surveys of estuarine nurseries, and a full-scale investigation of the Gulf fishery provided further information on population structure and size.

These studies resulted in extensive data files on catch, effort, age and size composition, and life history (migration patterns, stock homogeneity, and fecundity) from which we infer such dynamic characteristics of the stocks as growth, recruitment, and mortality rates. As a result of apportioning mortality rates between fishing and natural causes, the purpose of our studies has naturally expanded to include the effects of fishing on the stocks.

Scientific articles, written and oral reports, working conferences, personal meetings, and correspondence have maintained regular and frequent communication between the menhaden research staff, State and other Federal agencies, and the menhaden industry. Ninety articles on some aspects of the menhaden resource have been published since 1955. Of these, 30 have reported on the fishery, catch, effort, and size composition, or analyzed the growth, mortality, migrations and other dynamics of the populations. Several meetings a year have been held with the menhaden industry since 1953 at which research plans and results were discussed. Reports and conferences with State agencies, directly or through the Atlantic States Marine Fisheries Commission, GSMFC, and Gulf and Caribbean Fisheries Institute occurred one or more times each year. The Washington office of NMFS was involved in the preparation for these meetings and frequently participated in them. Recently these meetings have focused increasingly on management discussions. In the past 12 months there have been two meetings with the NMFS central office, three with industry, and several with the GSMFC that dealt specifically with resource management.

HISTORICAL BACKGROUND OF THE FISHERIES

The purse-seine fishery for menhaden began on the Atlantic coast after the Civil War. Catching efficiency undoubtedly increased somewhat by World War I as the carrier vessel fleet was steadily transformed from sail to steam and then to gasoline power; the towed purse boats were equipped with gasoline engines, and seine size increased. Methods of catching menhaden apparently changed very little between the two World Wars. The modern fishery began to develop after World War II, with the increased demand for fish meal and oil. There was a fairly continuous increase in number, size, and efficiency of harvesting gear, including spotting aircraft, up to about 1960.

The annual landings of Atlantic menhaden have shown a classic response to a progressively developing fishery. Landings increased fairly steadily to a peak in 1956 (Fig. 1) and then declined as the harvesting rate exceeded the growth rate of the menhaden population (the annual net increments of biomass from recruitment and growth of individual fish). The population, and hence landings, have

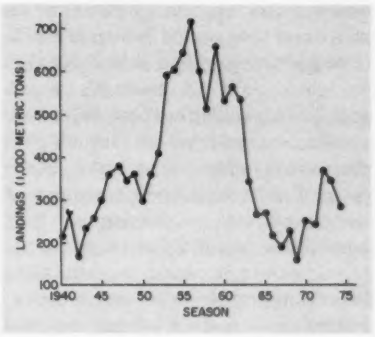


Figure 1.—Atlantic menhaden purse-seine landings in thousands of metric tons, 1940-1974.

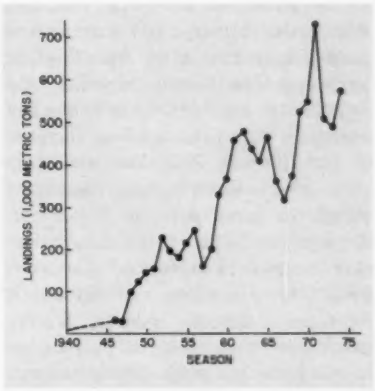


Figure 2.—Gulf menhaden purse-seine landings in thousands of metric tons, 1946-1974.

recovered greatly since the "bottom" in 1969. This is undoubtedly due, at least in part, to a 54 percent reduction in observed fishing effort, enhancing our belief in the efficacy of controlling the amount of effort.

The Gulf fishery began to expand in about 1947. Its technical development paralleled the post-World War II development of the Atlantic fishery, although there were time lags of a couple of years in some of the innovations tried first in the Atlantic (in general, most companies on the Gulf were and are the same as those on the Atlantic).

The landings on the Gulf show a trend (Fig. 2) since 1946 that is remarkably similar to that on the Atlantic, though of course starting at virtually zero rather than at about 200,000 metric tons. The Gulf fishery eventually reached a technically more advanced state than the Atlantic, with newer, larger, and more powerful vessels. Refrigerated vessels were introduced in 1956 and formed the majority of the fleet by

1964. These vessels allowed greater range and time on the fishing grounds.

Much consideration should be given to why the Gulf landings, though apparently peaking in about 1970, have shown no signs yet of declining so dramatically as in the Atlantic, in the face of a technical development of harvesting and processing at least equal to the Atlantic. Surely, part of the reason lies in imposing the increasing harvesting rates on a virgin stock, instead of on a stock already exposed to a substantial harvesting rate. Part of the reason may lie in some rather overt "management" by the industry. The same industry that experienced economic disaster on the Atlantic coast appears to be closely watching and voluntarily limiting the effort. For example, after a tremendous increase in the catch in 1971 (the maximum catch ever), the industry reduced its effort the next year by 5 percent. Though part of the reason for a reduction may have been induced by market, labor, or processing conditions, it indicates a flexible industry that is cautiously responsive to fluctuations in the resource supply. And, of course, the stock fluctuations in the Gulf are more apparent since there are fewer age classes in the fishery.

In summary, the history of these two fisheries indicates clearly enough 1) the danger of overfishing, 2) the positive effect of reducing effort in an overexploited fishery, and 3) the potential benefit of limiting effort in a healthy fishery.

MANAGEMENT ISSUES

In order to stimulate thinking that can lead to cooperative planning for management, with inputs from all concerned parties, it should be helpful for one party to discuss its views on several issues which are perceived, generally, to be crucial in developing specific plans. We should begin at the beginning by defining what we, as fishery biologists, mean by management. Our technical definition of fishery management is "controlling the rate of fishing," also called the fishing mortality rate. This fishing mortality rate is, for a given average population abundance, proportional to the catch. Conversely, for a given catch, it is inversely proportional to the average abundance. Fishing effort is defined and measured to be proportional to the fishing mortality rate. So, we can control the fishing mortality rate by controlling either the total catch or the total fishing effort. Sometimes we think of controlling not only the total fishing mortality rate but the rate applied to specified age groups in the population. This, of course, will affect the total rate and is a refinement of concept which will not be considered at this time.

Controlling (setting the level of) the fishing mortality rate, hence the average abundance of the stock and the catch from it, is done to benefit people, not fish. These social benefits can be ordinated, and range from gaining additional resources for consumers, on one end of the scale, through maximizing expected profits for the industry, or total physical yield, to preventing resource collapse, on the other end of the scale, for the benefit of future consumers and fishermen. Figure 3 is a schematic diagram of these social benefits, and is only a general example of the type of relation between catch and effort that we expect in many fisheries. The specific curves for Atlantic and Gulf menhaden will be presented in the next sections. At the left hand side we see that, with no effort, the catch is zero and the population size is at the maximum the environment will support. As effort increases, the population (numbers) decreases and the catch increases, since a larger fraction of the population is being harvested. This continues up to E_{max}, where the catch is maximized. If effort is fixed at any level then theoretically the catch will equal, on the average, the amount shown on the graph. At some point, however, labelled E_{crit} in Figure 3, the population will not be able to balance the weight removed by fishing, with new growth; the new growth comes from recruits entering the fishery and the growth of individuals. A hypothetical cost curve was drawn in the graph just to show three points: 1) if harvesting cost is proportional to effort and if the value of the catch is proportional to the weight of the catch, there is obviously some effort level (E_{opt}) where profits (equal to catch minus cost) are maximized, and this point is, in general, to the left of the point where catch is maximized; 2) so long as the value of the catch is greater than cost, effort in an uncontrolled fishery will expand until average profit is zero; when profit is negative, effort is removed; and 3) if the economic break-even point (EBEP) is to the right of the biological break-even point (BBEP), the fishery will collapse unless effort is limited (by factors other than free market competition) to some value below E_{crit}.

The concept of management espoused here is not one of "government, meddling in the economic affairs of industry," but one of developing models of the fishery which specify alternatives and, with cooperation from all concerned parties (State and Federal governments, and industry), decide the appropriate mix of social benefits as the objectives of effort limitations. This concept is not radically different from an industry concept of economic regulation which, though not often stated explicitly, goes something like the second point

Purse boats alongside as the catch is pumped into the hold of the carrier vessel.

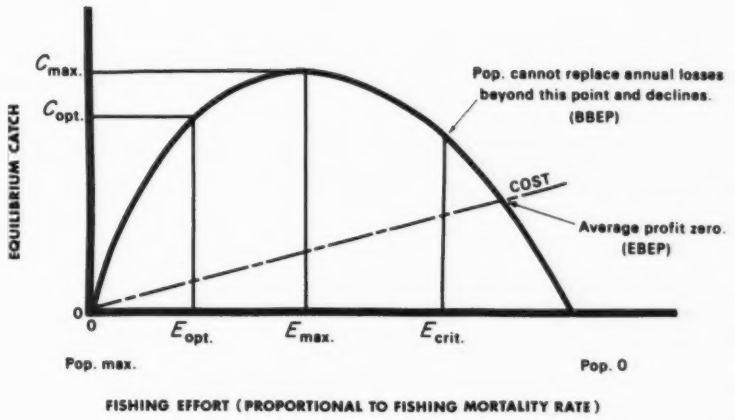


Figure 3.—Equilibrium catch as a function of fishing effort, with biological break-even point (BBEP). A hypothetical cost curve is drawn with an economic break-even point (EBEP). Several management alternatives are shown: 1) Economic catch (C_{opt}) at optimum effort (E_{opt}); 2) Maximum sustainable catch (C_{max}) at corresponding effort (E_{max}); 3) A critical amount of effort (E_{crit}) that reduces the population and resultant catch to a level below which it cannot replace itself.

in the above paragraph. Allowing the fishery to be controlled only by the economics of free market competition, however, does two things: it assures that 1) the average profit for the whole industry will be zero, a great social cost in terms of lower landings at higher cost, and "wastage" of excess labor and capital, and 2) there is no mechanism that provides for protection of the resource, since if either costs go down or value goes up new effort can afford to enter the fishery and eventually may exceed the BBEP. This second point is an expressed concern of the industry, at this time of greatly increased fish meal prices.

There are two further considerations in deciding objectives for fishery management. As indicated in the above paragraph, a management plan with a single objective often results in more than one social benefit. Moving from E_{crit} to E_{max}, the effort required to harvest the maximum sustainable yield, in Figure 3, would simultaneously increase the catch and profit, protect the resource, and probably decrease the number of jobs. The objectives chosen also will influence the methodology of regulating the fishing mortality rate. We have seen that the fishing mortality rate can be controlled, in general, either by limiting the effort or the catch. Management discussions frequently center on methods, but we believe objectives should be discussed as well, since a specified objective determines, at least partially and in general, the method. If we have a purely biological objective, such as achieving the maximum sustainable catch, it will be sufficient to regulate the catch. If we have any form of economic rationalization as our management objective, it is necessary to limit the amount of effort, and to do so in a manner that does not deter harvesting efficiency.

It is easier, politically and operationally, to limit the catch, and there are few disadvantages in doing so. As with any management plan, flexibility is necessary. A constant catch will not necessarily achieve a constant and desired fishing mortality rate if the population size is changing greatly for reasons independent of the fishery (e.g., unusual recruitment or changes in the natural mortality rate). Another disadvantage of catch quotas is that, in general, they lead to overcapitalized fisheries. The major difficulties with limiting effort are: 1) overcoming the legal barrier of limiting open access to a common property resource; 2) the actual mechanics of changing, and accounting for, the amount of effort—particularly with changes in gear efficiency; and 3) if effort is being limited to maximize profit, there is the problem of variability in the economic parameters and in determining the proper discount rate.

In view of the time-consuming technical difficulties of implementing any management scheme, the policy difficulties of determining an optimum strategy (which we believe can only be approached on a trial basis rather than determined once-and-for all initially), and the inherent volatility of many fisheries; we suggest adopting a philosophy of opting for minimal management objectives, implementing them as soon as possible, and building in as much flexibility as possible. This can be achieved by setting catch quotas initially, while we work on the problem of limiting effort. Catch quotas should be expansionary (i.e., allow for annual increases) in fisheries that show no signs of overfishing. They should be restrictive in overfished stocks. This means quotas should be at, or slightly below, what the effort is capable of harvesting, if effort is greater than E_{max} and less than E_{crit}. If effort approaches E_{crit}, quotas should be set considerably below what the effort can harvest, to allow the stock size to increase. The ultimate objective of manipulating the catch quota should be to drive fisheries toward, and maintain them near, the maximum sustainable catch. The implications of this philosophy, as applied to the menhaden fisheries, will be discussed in the next two sections dealing with analyses of the fisheries.

Both the Atlantic and Gulf menhaden fisheries present a favorable opportunity for establishing a management plan for the maximum, safe, and profitable utilization of the resources. They are free from many of the complexities that plague management decisions in many of our large, valuable fisheries. Both fisheries are 1) wholly domestic, 2) single species, 3) harvested and processed with the same technology, 4) well studied, and 5) vertically integrated. The differences between them and relative priority for management will be deferred to the following sections, which will specify the biological aspects of management plans.

We recognize the great need for other inputs, especially economic. Any existing scheme of exploitation of a

renewable resource is a form of management. Unrestricted application of capital (fishing effort) results in a certain yield taken with an associated cost to industry and society. Any alternative management scheme also has associated costs. The fundamental question is whether the benefits from a specified management scheme are economically superior to the existing scheme. In other words, various management alternatives should be specified economically. The choice of a particular scheme may be based ultimately on considerations in addition to pure economics. For example, it may be economically feasible, and desirable, for an industry with a high discount rate to fish a particular stock to extinction, but society may be entitled to a low discount rate for high demand goods that are likely to become scarce in the future. On the other hand, in an unregulated fishery the population level at which unit price equals unit harvesting cost may be sufficiently large to be sustainable. Answers to these questions require knowledge of costs, revenues, and discount rates. In addition, we must evaluate the social costs of research, implementation of regulations, and decreased yields (if they exist) from no regulation. All of these must be evaluated against the present and future value of the fishery.

There must be a parallel development of plans, which are continuously modified, and institutional mechanisms for implementing the plans. This will take the full cooperation of biologists, economists, fishermen, administrators, and State and Federal legislators. The fisheries commissions of the Gulf and Atlantic States might serve as the coordinators. They should actively solicit recommendations, review them, and encourage States to implement those they endorse.

AN ANALYSIS OF THE GULF MENHADEN FISHERY

There has been one technical publication (Chapoton, 1971) on the Gulf fishery, which attempted to analyze trends in catch and effort, and to model the effects of fishing on the stock and expected yields, in relation to effort. A Schaefer-type, or linear surplus yield model was presented which was fitted to data from 1946 to 1970. Based on the published model (Fig. 4), the average equilibrium catch can be estimated from effort by the following formula:

$$\text{Catch} = 2.12(\text{Effort}) - 0.0026(\text{Effort})^2$$

This model would predict a maximum sustainable yield of 430,000 metric tons with 408,000 vessel-ton weeks (the units of effort used).

This type of model which requires only catch and effort data provides a minimum amount of insight into the dynamics of the stock and should be used with a great deal of caution in formulating any management plans. Deducing the long-term response of the stock to exploitation from a model of this sort is extremely uncertain, unless information on age structure, growth rates, and mortality rates is considered also. One especially troublesome technical difficulty with this approach is the sensitivity of the parameters (which determine the maximum catch and associated effort) to the data set included in the calculations. An estimation of the maximum catch is especially uncertain when there are no data points on the descending portion of the curve. Hence the model should continue to be updated and recalculated every year. Figure 4 shows the model updated by the inclusion of only 2 years, 1971 and 1972. We see that it predicts a much greater maximum sustainable yield (MSY), 478,000 metric tons with 460,000 vessel-ton weeks, than an estimate of 430,000 metric tons only 2 years previously. If catches had been limited in 1970 to something near the estimate of MSY at that time, the industry would have suffered losses totaling about 130,000 metric tons. Even the current estimate of MSY, as a quota, would have seriously underestimated actual yields during the last 3 years. This example is intended to motivate the rationale for a quota system described next, and to demonstrate our concern not only for protecting the resource but minimizing industry losses as well, in this extremely valuable fishery.

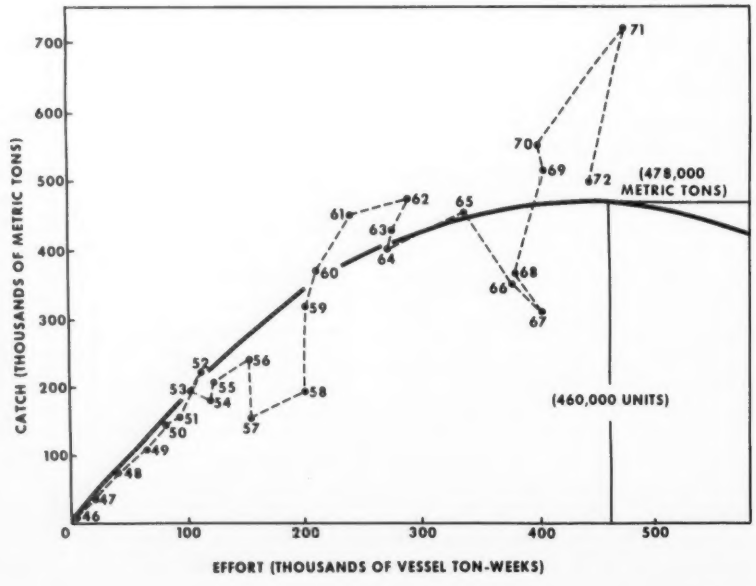


Figure 4.—Estimated average sustainable yield of the Gulf menhaden purse-seine fishery, 1946-1972. A maximum sustainable yield of 478,000 metric tons is shown with 460,000 vessel ton-weeks of effort.

MANAGEMENT RECOMMENDATION FOR THE GULF MENHADEN FISHERY

For reasons mentioned in the section on management issues, we propose a quota system as an initial step toward managing this fishery. In light of the above example, the system must not be too restrictive, but must allow for expansion, until there is clear evidence that we have reached, or

Menhaden reduction plant near Beaufort, N.C.

slightly passed, the peak of production. Setting annual quotas would simply allow the industry to approach the peak systematically and gradually, with fixed catches each year. Effort must be closely monitored each year to help us determine the validity of our estimated MSY. Even when we are more certain of the MSY, it might be necessary to adjust the quota frequently in response to fluctuations in the size of incoming year classes. Gradually increasing the quota past our predicted MSY is predicated on the assumption that Gulf menhaden, which have a high reproductive potential, are resilient enough to withstand overfishing (i.e., removing more than the annual surplus) for a couple of years. Thus we can set liberal quotas, which would not penalize the industry.

By way of example, if we were to initiate such a system for 1975, we would set a quota that is based on our current estimate of MSY (478,000), plus an increment based on statistical confidence limits around this point estimate. The upper value of MSY with 80 percent confidence is 520,000 metric tons. The industry should be able to land this catch with no great increase in effort, say 10 percent greater than the estimated 460,000 vessel-ton weeks, unless we have greatly overestimated the potential productivity of the stock. We would certainly not recommend this large an increase in effort in 1 year, since, in general, it is much more difficult to remove excess effort than it is to gradually increase effort. If the quota were not landed for a couple of years, with a reasonable amount of effort, then it should be revised downward nearer the actual catches. This system could be implemented immediately if an official organization, say the GSMFC, would propose a quota and the industry would agree to voluntarily abide by it. The Atlantic Estuarine Fisheries Center currently monitors daily catch records on a short time basis and would know if and when the quota is reached.

There are several advantages from this quota system. Firstly, it would discourage entry of "new" effort. The extremely favorable economic condition of the Gulf fishery has already attracted the interest of investors outside the traditional industry. We are fairly certain that the existing industry already has a capability to fully utilize the resource; and if new companies were to enter, it should be, from a resource point of view, only by buying out existing companies. Annual quotas also eliminate uncertain fluctuations in yield, which appears to us to be an advantage, though we are not capable of evaluating this economically. Perhaps the greatest advantage, however, is that a control mechanism will exist which, hopefully, will prevent gross overfishing and a large decline in the resource and landings. At this time we cannot quantify the benefits from management. The proposed immediate plan would require no new funds.

Analysis of this fishery is only beginning and is extremely incomplete at this time. The immediate greatest research needs for fuller understanding of this fishery, and to which we are directing our attention are: 1) valid information on the age structure of the population from which we can deduce mortality rates, 2) an assessment of our measure of effort to determine if it is proportional to apparent mortality and directly influences population abundance, and 3) valid techniques to quantify the strength of incoming year classes upon which quotas can be modified.

ANALYSIS OF THE ATLANTIC MENHADEN FISHERY

We have a more detailed understanding of the Atlantic fishery, due to more data and more analyses. As we shall see, this does not necessarily ease the task of developing rational management plans. There are complexities in this fishery, discussed below, which make a simple quota system less suitable for management, though we still recommend such an approach as a first step.

Schaaf and Huntsman (1972) summarized much of the analysis that has been done that bears directly on the dynamics of the stock and its response to harvesting at various rates. Two models are presented; a Schaefer-type, as used in the Gulf fishery, and a special form of what is usually called a dynamic pool model, which requires estimates of natural mortality rate, fishing mortality rate, growth rate, and a spawner-recruit relationship. The implications of these models for management and some of the difficulties of using them will be discussed here.

The first model predicts catch from effort by the following equation:

$$\text{Catch} = 1.247(\text{Effort}) - 0.000623(\text{Effort})^2$$

The estimated MSY from this model is 620,000 metric tons with 1,000 vessel-weeks of effort. Effort has been adjusted in the model for changes in gear efficiency, due to technical improvements and to a declining population. This ensures that the measure of effort used is proportional to fishing mortality. The method of adjustment

required information on the age structure of the catches, so it has not been applied yet to the Gulf fishery. The greatest difficulty with using adjusted effort is translating it, on a real-time basis, back into units of observed effort. We will discuss this further when we present, below, an updated version of the model.

The dynamic pool model predicts a maximum sustainable yield of 400,000 metric tons instead of 620,000. We attribute this large difference primarily to the unusually abundant year classes of 1955, 1956, and 1958. These three year classes contributed the bulk of the large catches from 1955 to 1962. In fact, if one were to assume, somewhat arbitrarily, that catches from these year classes were only "average," then an estimated MSY would be only about 360,000 metric tons. The dynamic pool model however, incorporates the average recruitment expected from the number of spawners present, in calculating yields. It probably provides, therefore, a more representative picture of present sustainable yields from average year classes. The chief difficulty in using this model for immediate management planning is, again, one of translation. The model predicts yields for a given fishing mortality rate, and it is difficult to translate observed effort into a fishing mortality rate, on a real-time basis. It is only after a couple of years that we can estimate the mortality rate generated by a given amount of effort. We believe this model is useful, however, as a conceptual framework of stock dynamics against which to check deductions from simpler models. Also it permits deductions about equilibrium age composition of the stock, against which we can check the current status of the stock.

Since the publication of these models, we have updated the linear surplus yield model. In addition to adding 4 years of data, we have adjusted 6 more years of effort data, bringing the base year up to 1971. This makes the problem of translating observed effort into effective effort somewhat easier, since it is nearer in time to the base year and fewer changes have occurred. For 1972 and 1973 we assumed no change in efficiency and therefore did not adjust the effort. A Schaefer-type model fit to these data (Fig. 5) predicts an MSY of 560,000 metric tons, with 630 vessel-weeks of effort (1971 units). There appear to be two distinct eras of the fishery. From 1955 through 1962 the virtual population (i.e., total numbers caught out of a year class) averaged 3 billion fish (standard error equals 0.8 billion), and the weight landed annually during this period averaged 596,000 metric tons (standard error equals 25,000). From 1963 through 1973 catches averaged 266,000 (standard error equals 20,000) from virtual populations that averaged only 1.3 billion (standard error equals 0.1 billion). From 1968 through 1971 there has been a 30 percent reduction in effort, which we feel is partly responsible for allowing the catches to rebound to the current level of 350,000 metric tons. Catches for 1972 and 1973 are not only near the equilibrium yield curve shown in Figure 5 but are also near the average maximum level (400,000 metric tons) predicted from the dynamic pool model. Catches of 550,000 metric tons are probably not possible, with any level of effort, unless several large year classes enter the fishery. Even then, to achieve large landings would require a mortality rate low enough to allow larger numbers of fish to reach older ages and, hence, greater weight. The dynamic pool model indicates that, with maximum equilibrium catch, the fishing mortality rate would be such that 17 percent of the catch would come from ages 3 and greater. Low catches in the late 1960's were mostly of ages 1 and 2 years; in recent years the age composition of the catch has shifted toward older ages, but not quite enough. In 1972, 11 percent of the catch was 3 and greater. Figure 5 indicates that 950 vessel-weeks is sufficient to harvest the average equilibrium catch. The slight reduction in effort from 990 in 1973 to 950 might be sufficient to take advantage (in the long run) of exceptionally large year classes.

The point indicated on the far right (Fig. 5) is an estimate of what we above called the biological break-even point (BBEP). There is a fair amount of uncertainty involved in estimating the BBEP, especially for animals with life history patterns that permit large fluctuations in abundance. This estimate came from the dynamic pool model, by simulating the population through time and finding the maximum mortality rate (and associated yield) that the population can sustain without declining eventually to zero. Though we do not know how reliable this estimate is, we believe it is important to begin thinking about this critical point. There is reason to believe that the industry

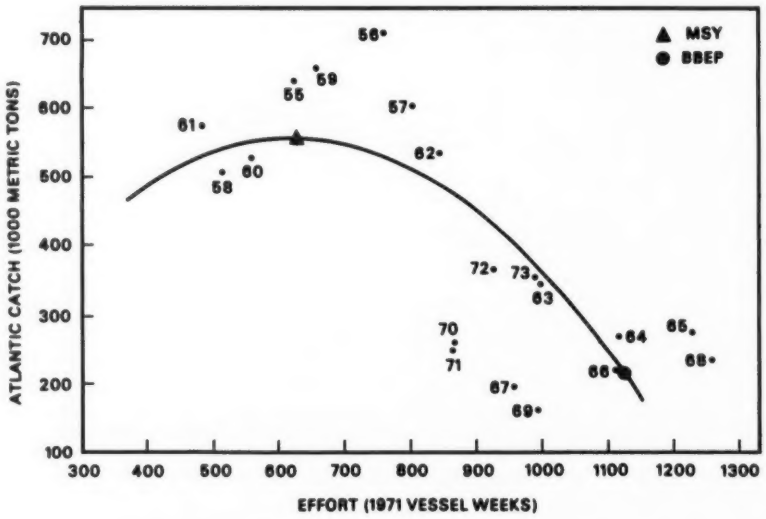


Figure 5.—Estimated average sustainable yield of the Atlantic menhaden purse-seine fishery, 1955-1973. A maximum sustainable yield (MSY) and the biological break-even point (BBEP) are shown.

approached this point in about 1964, when catches dropped into the 200,000 metric ton level for the first time since 1944, with about 1,100 vessel-weeks (adjusted to 1971). For the next 5 years, even though 50 percent of the observed effort was removed, the catches declined steadily to the lowest ever (161,400 metric tons in 1969). We can only speculate on what would have happened if the effort had stayed in the fishery. We know effort left the fishery for economic reasons; we are fairly certain it could now afford to stay in, even if catches dropped to 200,000 metric tons, with the currently higher fish meal and oil prices. A quota system for the Atlantic menhaden fishery must be responsive to a demonstrable need for resource protection.

MANAGEMENT RECOMMENDATION FOR THE ATLANTIC MENHADEN FISHERY

The 1973 point on the curve provides a reasonable starting place for implementing a quota system. According to the model, 990 vessel-weeks of effort should land, on the average, about 370,000 metric tons. The objectives of the plan should be to set quotas that: 1) discourage effort increases, which would result in lower catches in the long run, higher costs, and move the fishery nearer the BBEP, if not adequately controlled; and 2) encourage effort decreases, which could allow the population to rebuild and eventually allow increases in the quota. If effort stays at 990, we would recommend a quota of no more than 370,000 metric tons. If the quota were set below 370,000 the population might rebuild, and quotas could be increased gradually to 400,000 if effort is reduced. If effort should increase beyond 990 the quota should be reduced. If effort increases to 1,120 vessel-weeks without management, the quota should be less than 220,000 tons, because we are fairly sure the population could not sustain that level of harvest.

The fact that one population exists along the entire coast, that migrates north and south throughout its range, and that is stratified by age and size along the coast causes more than the usual kinds of allocation problems associated with a single quota. A fixed tonnage of fish removed from the population causes a higher mortality rate if composed of young fish than it does if composed of older fish, because there are more of them per ton. On the other hand, the natural mortality rate is high enough that maximum tonnage cannot be achieved by fishing only on the older ages. The maximum weight of a year class occurs between the ages of two and three, therefore this would be the optimum age at which to harvest fish. We believe that the only way to obtain the maximum yield from this fishery is by a geographical distribution of catches similar to that prevailing during the peak years (1953 to 1962).

SUMMARY AND CONCLUSIONS

Our menhaden fisheries are extremely valuable and an important source of protein. We have seen the Atlantic fishery decline significantly and partially rebuild. In the Gulf fishery we have seen the dramatic growth rate in landings begin to level off and the threat of excessive effort entering. We have recommended a limited scheme of management based on single quotas, that should prevent overfishing and economic difficulties for the industry while we jointly consider refinements that could optimize resource management plans. Both fisheries would be relatively easy to manage, compared to international, multispecies fisheries. Both fisheries could benefit: the Gulf, from prevention of collapse; the Atlantic, from increased yields at lower costs. The probability of achieving the benefits is high; the risks are low. The proposed immediate plan would require no new funds. We should all work together to ensure the maximum, safe, and economical utilization of this great natural resource.

ACKNOWLEDGMENT

This report was made possible by the menhaden and biometric data processing staff at the Atlantic Estuarine Fisheries Center. I especially wish to thank Robert B. Chapoton and James E. Sykes for their help and suggestions.

LITERATURE CITED

Chapoton, R. B. 1971. The future of the Gulf menhaden, the United States' largest fishery. Gulf Caribb. Fish. Inst., Proc. 23rd Annu. Sess., p. 134-143.

Graham, M. 1949. The fish gate. Revised ed. Faber and Faber Ltd., Lond., 199 p.

Schaaf, W. E., and G. R. Huntsman. 1972. Effects of fishing on the Atlantic menhaden stock: 1955-1969. Trans. Am. Fish. Soc. 101:290-297.

MFR Paper 1156. From Marine Fisheries Review, *Vol. 37, No. 9, September 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1157

Some Observations of Feeding Behavior of Bottle-Nosed Dolphins (*Tursiops truncatus*) in the Northern Gulf of Mexico and (*Tursiops* cf *T. gilli*) off Southern California, Baja California, and Nayarit, Mexico

STEPHEN LEATHERWOOD

ABSTRACT—Recurring feeding patterns are reported for bottle-nosed dolphins, Tursiops *spp., from the northern Gulf of Mexico, the west coast of Mexico, both coasts of Baja California, and southern California. Seven distinct feeding behaviors, in which a variety of prey species are taken by various means, are identified and discussed. Exploitation of by-products of human activities in all areas suggest that* Tursiops *have learned their advantages in providing food. Other feeding patterns involve interesting behaviors to permit exploitation of shallow marshlands, efficient hunting and harvesting using echolocation in shallow water, and cooperative taking of prey. Plasticity in feeding behavior appears to have adaptive value if bottle-nosed dolphins have limited home ranges and must, therefore, cope with seasonal fluctuations in "local" productivity. Analysis of the stomach contents of one animal taken off Mississippi supports contentions of catholic tastes and opportunistic feeding behavior for* Tursiops.

INTRODUCTION

The food habits of wild dolphins[1] are usually determined from examination of stomach contents of beach-stranded or accidentally killed specimens of animals taken in the few aboriginal fisheries. For most species, very little is known of patterns of feeding, and few papers deal with the manner in which prey are taken. For the bottle-nosed dolphins, *Tursiops* spp., off the United States and Mexico, accounts of food and feeding habits are apparently limited to those summarized in Table 1. This dearth of information is surprising, since *Tursiops* spp. is frequently maintained in captivity and is generally the best known of all small cetaceans. This paper reviews the information available on *Tursiops*, adds recent observations, and discusses recurrent feeding patterns.

[1]Although the author considers the terms dolphins and porpoise interchangeable in the common names of odontocetes, the term dolphin is used throughout this paper. References should not be confused with the dolphin fish, *Coryphaena* spp., which is not discussed.

During a summer (July) assessment of stocks of Atlantic bottle-nosed dolphins, *Tursiops truncatus*, in the northern Gulf of Mexico off Alabama, Mississippi, and eastern Louisiana (Leatherwood and Platter, 1975), I had numerous opportunities to observe feeding behavior. The best observations were made at low speeds and at altitudes of from 30 to 50 meters from a Cessna 172 Skyhawk[2]. An aerial fish spotter assisted with identification of prey species.

In addition, I have made or received reports of similar observations of feeding behavior of Pacific bottle-nosed dolphins *Tursiops* cf *T. gilli* off the west coast of mainland Mexico (Nayarit), off both coasts of Baja California, and off southern California. In these instances, observations were made from fixed-wing aircraft (Navy S-2's and Cessna 172's), Navy helicopters (H-3's), charter fishing boats, small skiffs, and shore vantage points.

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Despite the wide separations in locality and the often very different habitats, there were numerous similarities in feeding behavior. In all, seven different feeding patterns have been identified, each related to the circumstances of feeding and the prey species involved. The first three involve feeding in association with shrimp boats and suggest that the dolphins have learned the advantages of this human activity in providing food. The remaining four are methods of pursuing and taking prey, individually or in cooperation, not in the presence of human activity. To avoid confusion when the patterns are cross-referenced in the text, each has been numbered.

1. FORAGING BEHIND WORKING SHRIMP BOATS

The most striking and frequently reported feeding pattern for bottle-nosed dolphins is that in which a herd follows a working shrimp boat, apparently feeding on organisms stirred up by its otter trawls. This behavior has been documented for the northern Gulf of Mexico and for the Atlantic coast of Florida. Gunter (1938) reports bottle-nosed dolphins following shrimpers off the Texas coast and apparently causing damage to their nets. He adds (Gunter, 1942) further anecdotal evidence of the species' feeding behind working shrimpers, noting that in the

Stephen Leatherwood is with the Biomedical Division, Biosystems Research Department, Naval Undersea Center, San Diego, CA 92132.

Table 1.—A summary of published accounts of food and feeding behavior of bottle-nosed dolphins, *Tursiops* spp., off the United States, Baja California, and mainland Mexico.

Reference	Species	Summary of report
True (1885)	*T. truncatus*	Report of common gunnard, *Prionothus carolinus*, in stomachs of both females examined at the Cape May Fishery.
Townsend (1914)	*T. truncatus*	Second-hand report of fishermen that animals taken in the Hatteras fishery fed primarily on squeteague or weakfish.
Gunter (1938)	*T. truncatus*	Report of animals following working shrimp boats feeding.
Harris (1938)	*T. truncatus*	Two photographs and a brief description of feeding on striped mullet, *Mugil cephalus*, off St. Augustine, Fla., including the dolphins catching their prey in midair.
Kemp (1949)	*T. truncatus*	Reports of squid (*Loligo* sp.), shrimp and crabs (unidentified), and 9 fish species from stomachs of 10 animals collected off Texas. Striped mullet (*M. cephalus*), hardheads (*Galeichthys felis*), and ribbonfish (*T. lepturus*) were most numerous.
Gunter (1942)	*T. truncatus*	Report that animals in northern Gulf of Mexico fed most commonly on striped mullet, *Mugil cephalus*, but also took puffer, needlegar, sheepshead, black drum, spotted and sand trout, flounder, croaker, and shrimp; comments further on feeding behavior.
Gunter (1951)	*T. truncatus*	Second-hand report from E. I. McIlhenny of whole shrimp in stomachs.
Gunter (1954)	*T. truncatus*	A comprehensive review of knowledge to date.
Norris and Prescott (1961)	*T. gilli*	A report of stomach contents of a single animal plus anecodotal records of feeding, all in association with human activities.
Hoese (1971)	*T. truncatus*	An account of dolphins feeding in shallow *Spartina* marshes of Georgia coast.
Caldwell and Caldwell (1972)	*T. truncatus*	Anecdotal accounts of types of feeding behavior and a review of knowledge.

same area the dolphins had learned to distinguish between a cruising shrimper and one whose engines were laboring to drag the nets and often showed up shortly after the trawls began. Caldwell and Caldwell (1972) add similar discussions of feeding behind shrimpers for the Atlantic coast of Florida.

In the aerial survey of the northern Gulf of Mexico (referred to hereafter as north Gulf survey) dolphins were observed feeding behind working shrimpers 12 times. Typically, they followed the boat in a loose aggregation (Fig. 1) with subgroups of the herd swimming back and forth through the boat's mud boil in an erratic zigzag pattern, diving and feeding individually (Fig. 2).

In only three instances were prey actually seen in the mouths of animals and those, of course, were unidentifiable from the aircraft. That the animals were feeding in other instances, however, was evidenced by their sudden changes in direction, their rapid swimming, their irregular diving intervals, and the tenacity with which they stayed with the shrimpers.

Although Norris and Prescott (1961) briefly mention an association of bottlenosed dolphins with shrimpers near San Felipe, Baja California, in the western Sea of Cortes (lat. 31°02′N, long. 114°51′W), there is no published record of the species feeding behind working shrimpers in the Pacific Ocean.

During a 2-year study of the bottlenosed dolphins near San Felipe and Puertocitos (lat. 30°25′N, long. 114°40′W) in 1972 and 1973, Wayne Turl (1974, pers. commun.) frequently observed herds of dolphins working in the mud boil behind shrimpers, presumably feeding. The majority of incidents occurred from October through June inclusive, the period which he reports as the most active months for the fishery.

On 22 September 1974, I observed

Figure 1.—The "mud-boil" created behind a "Texas" shrimper working off Isla au Pitre, in the Mississippi Sound (lat. 30°08′30″N, long. 89°13′30″W), 3 July 1974.

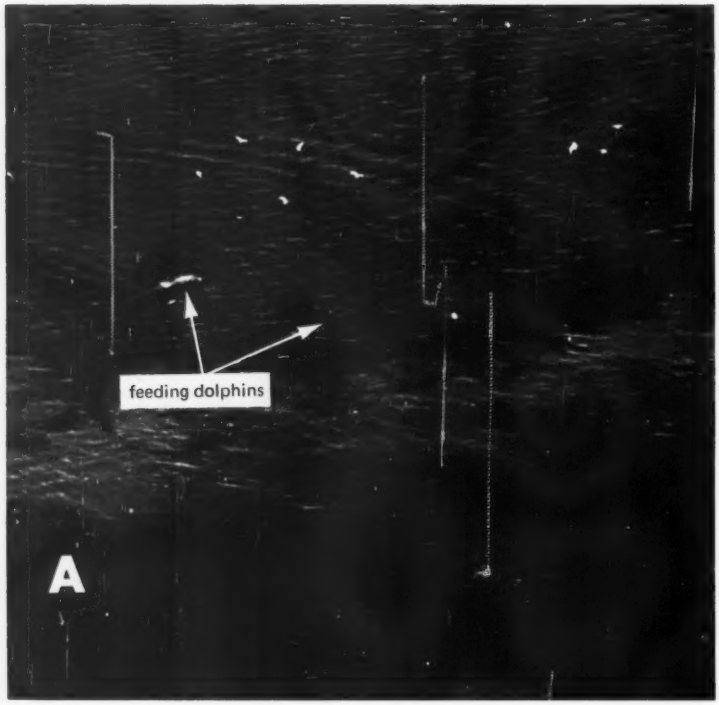
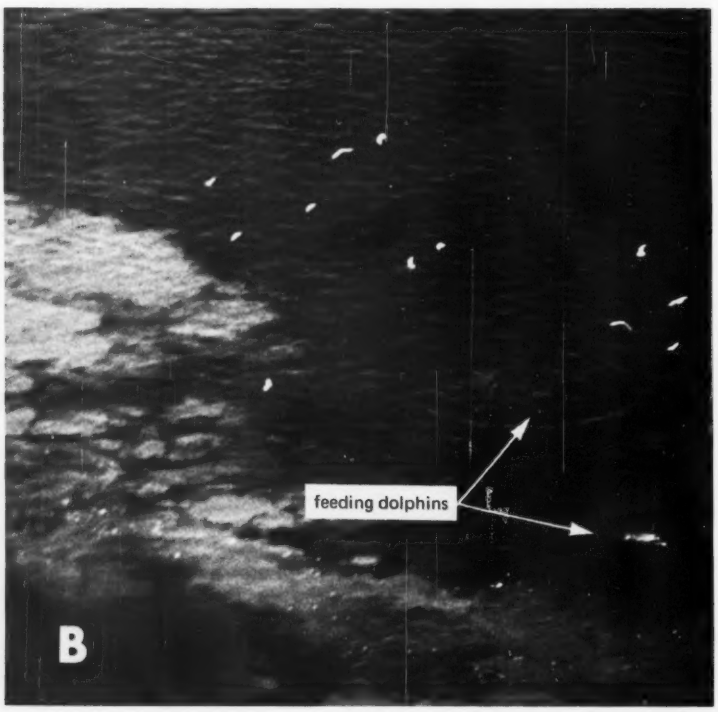


Figure 2.—(A,B) Dolphins (arrows) feeding among the "mud-boils" created behind a "Texas" shrimper working off Isla au Pitre, in the Mississippi Sound. Note the abundance of birds come to feed on debris. Bottle-nosed dolphins are frequently observed feeding in this manner.



this same type of behavior by a herd of 13-15 bottle-nosed dolphins in shallow water off Playa Blanca (lat. 31°23′N, long. 115°13′W), approximately 20 miles north of San Felipe. As in the accounts reported by Turl, the dolphins worked the mud boil in the shallows near shore. In neither Turl's reports nor in the instance I observed did the feeding patterns of the dolphins differ in any important respect from those described for the Gulf of Mexico.

Bottle-nosed dolphins apparently feed in association with other netting operations as well. Busnel (1973) describes *Tursiops* feeding on mullet (*Mugil cephalus* and *M. auratus*) during beach seining off Mauritania and comments on the "symbiotic" nature of the relationship between the dolphins and the fishermen. Frank M. Truesdale (1974, pers. commun.) has observed dolphins feeding "behind" a commercial beach seine in Caminada Bay, La. (lat. 29°40′N, long. 90°00′W). The dolphins, working outside the bag, pulled at fishes gilled in the net as it was dragged ashore.

2. FEEDING ON TRASH FISH

A second feeding pattern also involves the dolphin's capitalizing on shrimp fishing activities. Once they have completed a trawl, shrimpers often dump the catch on the deck and sort it, keeping the shrimp and the fish of commercial value but discarding the fish of no commercial value. Norris and Prescott (1961) and Caldwell and Caldwell (1972) provide detailed accounts of dolphins gathering around shrimpers in the Gulf of California and the east coast of Florida, respectively, and feeding on the discards. Norris and Prescott (1961) add that the dolphins in the north Gulf frequently arrive immediately after the engines shut down and sorting begins. Phillip Stevens (1974, pers. commun.) reports that in the Mississippi Sound dolphins frequently follow shrimpers from the waters of the fishing grounds to the harbors in the early morning, presumably taking advantage of fish discarded on the return trip.

In the north Gulf survey, dolphins were seen on three occasions in the company of drifting shrimpers where

catch was being sorted, apparently taking fish thrown over the side. In each case, however, other dolphins were seen nearby feeding on mullet and ignoring the discards. No consistent differences in animal size could be determined among the dolphins feeding in these two manners.

Turl (1974, pers. commun.) has noted similar instances involving shrimpers and bottle-nosed dolphins in the waters near Puertocitos and San Felipe.

On 22 January 1973, I observed six *Tursiops* feeding on northern anchovies, *Engraulis mordax*, thrown over the side of a sport fishing boat near Barracks Beach, Guadalupe Island (lat. 29°09′30″N, long. 118°16′30″W). The dolphins circled the boat for over an hour, diving at irregular intervals, but rushing periodically to take the fish thrown over the side.

3. FEEDING ON FISH ATTRACTED TO NONWORKING SHRIMPERS

In the third pattern noted, the dolphins apparently take advantage of fishes as they seek sanctuary beneath anchored vessels. For example, the majority of shrimpers generally work at night. Frequently, boats can be seen during the day "laying to" or at anchor, with their nets trailing in the water or hanging on the outriggers. At these times, the combination of debris from the nets and discharge from the bilges frequently attracts numerous fishes, including sharks, to the area of the boats.

On two occasions during the north Gulf survey dolphins were seen in the vicinity of anchored shrimpers feeding on fishes apparently attracted there. In both instances, feeding groups were small—four and six individuals. In both, the dolphins chased small schools of unidentified bait around the area. Sharks and numerous birds trailing the dolphins or generally patrolling the area cleaned up debris as well. Dolphins in the Mississippi Sound are frequently seen around shrimp boats anchored after a night's work, (Phillip Stevens 1974, pers. commun.).

I have observed *Tursiops* feeding near anchored vessels on four other occasions: 1) on 31 December 1970, six to eight bottle-nosed dolphins were feeding both near an anchored tuna seiner and near the effluent from the fish-processing plant in the bay at Cabo San Lucas, Baja California (lat. 22°52′N, long. 109°53′30″W); 2) on 21 April 1971, two groups of four bottle-nosed dolphins each were observed feeding around anchored fishing boats just off the pier at Puerto Vallarta, Bahia de Banderas, Nayarit, Mexico (lat. 20°37′N, long. 105°25′W). In both instances the dolphins were actively feeding around the vessels for an hour. In both, numerous birds and some sharks were also feeding on attracted fishes; 3) on 22 January 1974, I observed *Tursiops* feeding on fish attracted by a night-light placed over the side of the MV *Cape Polaris* at anchor at Isla San Benito, Baja California (lat. 28°18′N, long. 115°34′W); 4) on 22 September 1974, I watched from an aircraft as two dolphins fed near anchored seiners off Ensenada, Baja California, Mexico (lat. 31°51′N, long. 116°37′W), and six others patrolled near fishing boats anchored off Camalù, Baja California, Mexico (lat. 30°45′N, long. 116°03′W).

Turl (1974, pers. commun.) reported that *Tursiops* were frequently attracted to anchored fishing boats near San Felipe and Puertocitos. The dolphins reportedly often continued to feed in the area of the boats for hours.

None of these observations is surprising in the light of the attraction of fishes to floating debris, ships, and cetaceans in the eastern tropical Pacific (Hunter, 1968 and Green, et al., 1971) and to artificial surface and submerged reefs in the northern Gulf of Mexico (Klima and Wickham, 1971). These floating bases rapidly become complex communities of prey, predators, and scavengers and provide a ready source of food for high-order predators.

In addition to these three feeding modes, each of which capitalizes on the by-products or results of human activities, *Tursiops* were observed actively pursuing fish, individually or in consort, in three other situations.

4. HERDING SCHOOLS OF FISH

Caldwell and Caldwell (1972) describe a type of cooperative feeding behavior as follows: " . . . a group of dolphins find(s) a large school of some pelagic fish, such as mullet or catfish and begin(s) to encircle it from above, around and below. The natural schooling behavior of such fishes is to keep in a tight ball so the circulating dolphins feed on the stragglers or some dolphins charge through the school while the others keep the ball intact. . . . "

During the north Gulf survey, behavior of this kind was observed on five occasions involving from two to as many as fourteen dolphins. One feeding was on menhaden, three on mullet, and one on an unidentified species. In general, the dolphins swam in tight circles around the fish, and individuals darted into the herd periodically to feed. On some occasions, the feeding individual charged the school from below, creating a sizeable surface boil or coming completely clear of the water. Truesdale (1974, pers. commun.) reported that in April 1972 he observed an identical feeding on menhaden by 12 bottle-nosed dolphins in the southwest portion of Caminada Bay, La. (lat. 29°40′N, long. 90°00′W).

On 20 September 1974, I watched about 40 bottle-nosed dolphins from aircraft in Bahia de la Santa Maria on the west coast of Baja California (lat. 24°47′N, long. 112°15′W). One small subgroup of five animals was circling a school of unidentified fish in the shallows with individuals taking turns charging in to feed.

On 13 December 1974, during a southern California aerial survey, I located six bottle-nosed dolphins 2 miles north of Pyramid Head, San Clemente Island, Calif. (lat. 32°51′N, long. 118°21′30″W). The next day six bottle-nosed dolphins, presumably the same animals, were located approximately 2 miles west of Seal Cove, San Clemente Island (lat. 32°54′N, long. 118°34′30″W). During both encounters the dolphins were cooperatively circling and feeding on small schooling fish, tentatively identified as anchovies. Individuals frequently created sizeable surface disturbances as they wheeled through the fish schools.

I have frequently observed a similar herding and feeding on anchovies off southern California by California sea

lions, *Zalophus californianus*, and North Pacific white-sided dolphins, *Lagenorhynchus obliquidens*. The sea lions in particular frequently catapult themselves into the air in the feeding process.

Turl (1974, pers. commun.) has observed this type of feeding for both *Tursiops* and *Zalophus* near San Felipe.

5. SWEEPING SCHOOLS OF SMALL BAIT FISH

Like pattern 4, the fifth feeding pattern involved cooperation among a group of dolphins. In this pattern, observed only twice during the north Gulf survey, small groups of dolphins (three and six) assumed a crescentic formation at the rear of a fleeing school of small fishes, thought to be menhaden in one instance, unidentified in another. The dolphins drove the school of fish ahead of them at high speed towards shallower water. The dolphins maintained approximately the same positions in the line relative to each other, despite the erratic movements of the fish. As they continued to drive the school in front of them, individual dolphins picked up stragglers or darted in periodically to take fish from the school.

A similar pattern of moving and taking prey has been noted for killer whales *(Orcinus orca)* feeding on California sea lions (Leatherwood and Samaras, 1974).

6. CROWDING

The sixth pattern is apparently a slight modification of pattern 5. For example, during the north Gulf survey three dolphins were observed in the marshlands crowding small, unidentified fish from deeper water onto shoals or against mud banks at the foot of clumps of salt grasses, *Salicornia*, and taking the fish as they flopped in a few inches of water. An extension of this type of behavior, involving the animal's driving fish completely out of the water onto a mud bank and sliding up the bank after them, was reported by Hoese (1971). Of particular interest was the surprising agility displayed by the dolphins in the extremely shallow water, both in the accounts reported by Hoese and in instances of feeding noted here. They appeared completely at home on the shallows even when up to 25 percent of the back was exposed. Several writers (e.g., Teal and Teal, 1969 and Caldwell and Caldwell, 1972) have noted that *Tursiops* are perfectly at home in shallows. During aerial surveys of Mississippi and Baja California, *Tursiops* have frequently been seen in the shallow waters (<3 feet or 0.9 meter) of the marshlands, lagoons, bocas, and mangrove swamps.

Feeding patterns 4, 5, and 6 involve cooperative taking of prey. The seventh involves individual fishing with an interesting behavioral variation.

7. INDIVIDUAL FEEDING

In 14 instances during the north Gulf survey individual porpoises were seen pursuing small schools of bait fish or larger individual fish up to 12 inches (25.4 cm) long in open water. Typically, this type of feeding was characterized by high-speed swimming, by quick bursts of speed, and by radical changes of direction. Once the dolphins reached the would-be prey, they usually fed by rapidly "pinwheeling" in the horizontal plane, a motion which swept the dolphin's head through the school or towards the individual fish. Once the rotation was completed the dolphin again set out in pursuit of fish.

The author has observed individual feeding with the wheeling motion at widely separated locations off southern California, Baja California, and mainland Mexico.

Of particular interest in these feedings is the frequency with which the dolphins pursued their prey either on their sides or upside down (Fig. 3). A typical cycle involved a quick respiration, a rapid turn onto the side or back, a high-speed erratic chase, and, upon arrival at the fish or school, the pinwheeling motion described above.

The author has observed upside-down feeding in the Mississippi Sound and adjacent marshlands, at La Misión (lat. 32°10′N, long. 116°54′W) and Camalu (lat. 30°45′N, long. 116°03′W) off the west coast of Baja California, and off Catalina Island, Calif. (lat. 33°12′N, long. 118°25′W). The dolphins frequently remained upside down for 30 seconds or more, and repeated the pattern on up to three successive dives.

An interesting, similar observation was reported by Thomas Smith, a charter fisherman from San Diego. Smith reported that while he was fishing for white marlin off Catalina Island (lat. 33°22′N, long. 118°15′W) in early September 1974, bottle-nosed dolphins approached and examined trolled bait. What caught his eye was the dolphins' behavior as they approached the bait; they inverted and made the last 50-yard run upside down, righting themselves only after they had veered off from the bait. This method of approaching potential prey seems to occur in locations and under conditions too widespread and varied not to have some adaptive value.

Side-swimming and upside-down swimming have been noted for *Inia geoffrensis* (Layne and Caldwell, 1964 and Caldwell et al., 1966) and for *Platanista gangetica* (Herald et al., 1969), both of which inhabit turbid, shallow waters. Although the adaptive advantages of the behavior are unknown, it is conceivable that rotating onto the back in this manner reduces surface echoes and distortion of the animal's echolocation signals. For example, Evans (1973) noted that for *Tursiops* the slope of the sound cone projected during echolocation is relatively flat ventrally but acute dorsally, relative to the animal's main body axis. By inverting, the dolphin can project a signal that is nearly parallel to the water surface and concentrates energy to ensonify a shallow target with a minimum of surface refraction. Energy projected downward would be dampened by the bottom.

When single dolphins were seen in the highly turbid marshland waters of Louisiana and Mississippi, where the animals were visible only at the surface, they were often detected by a meandering mud trail. These trails were frequently marked by large muddy areas, assumed at the time to be areas where the animals had overtaken their prey and fed in the manner described.

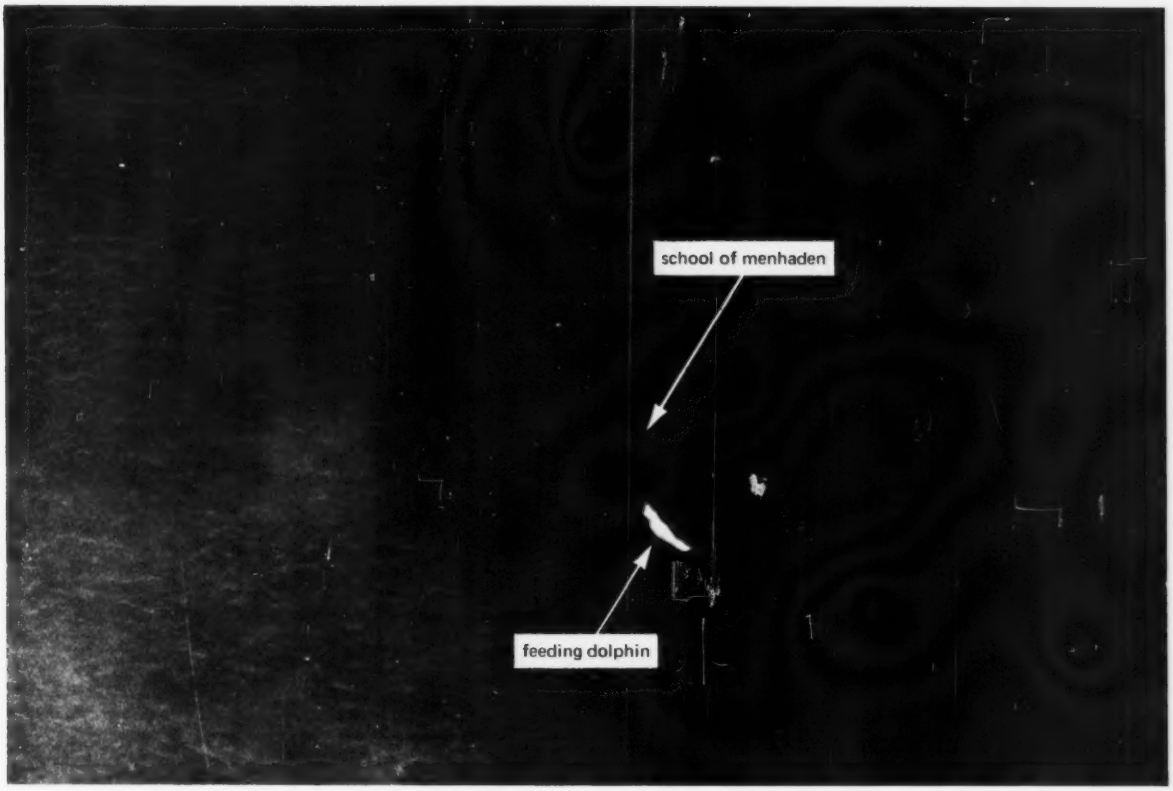


Figure 3.—A lone dolphin pursuing a school of menhaden in the waters off Cat Island, Mississippi Sound (lat. 30°10'30"N long. 89°06'W), 6 July 1974. Note that the dolphin is upside down. Dolphins were frequently seen feeding on their backs and on their sides.

DISCUSSION

Gunter (1954) notes that off the coasts of the northern Gulf of Mexico, at least, *Tursiops* is catholic in its feeding tastes and opportunistic in the sense that it tends at any given time and location to feed on the most abundant species. The accounts of Caldwell and Caldwell (1972) indicate that this description applies equally to the *Tursiops* of the Atlantic coast of Florida as well.

Norris and Prescott (1961) refer to "the remarkable degree of flexibility in the species' feeding habits, adapted to local and sometimes transient conditions." As an example they describe *Tursiops'* habit of following ferry boats in San Diego Bay, Calif., taking fish stirred up by the prop wash.

Kleinenberg (1938) reports that *Tursiops* in the Black Sea fed on nine different fish species, shrimp, and occasionally molluscs. Hideyuki et al. (1969) similarly reports that *Tursiops gilli* off Japan fed on a wide variety of fish species and, to a lesser extent, on squid. All these published reports and the miscellaneous observations of the species' feeding behavior reported in this paper support the earlier conclusions of Gunter (1954).

During the north Gulf survey (Leatherwood and Platter, 1975) bottlenosed dolphins were observed feeding at least once for each hour of daylight flown; they were noted feeding on a variety of organisms under a wide variety of circumstances.

The stomach of one animal cursorily examined at 1000 on 11 July 1974, at Pass Christian, Miss., contained the following species and approximate quantities by volume: menhaden (*Brevooria* sp.) 25 percent; striped mullet (*Mugil cephalus*) 20 percent; cigar minnows (probably *Decapterus* sp.) 5 percent; miscellaneous shrimps (*Penaeus* sp.) 10 percent; and silver eel (probably *Trichiurus lepturus*) 10 percent. All these species were newly ingested and nearly whole, and tentative identifications were made visually. The remaining 30 percent of the stomach's contents were badly decomposed, unidentifiable fish remains.

The observations for coasts of mainland Mexico, Baja California, and southern California similarly involve feeding on varied prey and under varied circumstances.

The recurrence of patterns over time at widely divergent locations suggests their adaptive value for the species. One line of reasoning is as follows. If bottlenosed dolphins are relatively limited in their ranges and have rather short-term movements, plasticity in food habits is necessary for survival. Caldwell (1955) first discussed the possibility of home range in the species. Reports of

fishermen in the Mississippi Sound suggest that the bottle-nose of that area are "resident." The waters of that region support tremendous summer populations of such organisms as menhaden, mullet, and shrimp. Because all these are largely seasonal, however, dolphins remaining in the area throughout the year must be sufficiently flexible to switch to other organisms.

Whatever the explanation, *Tursiops* often utilize seasonally abundant species and have learned to take advantage in widespread locations of human activities providing food.

ACKNOWLEDGMENTS

I would like to thank all the following colleagues who reviewed the manuscript and made useful suggestions for its improvement: David K. Caldwell, W. E. Evans, J. D. Hall, A. B. Irvine, J. G. Mead, F. K. Rodgers, Frank M. Truesdale, and F. G. Wood.

Frank Truesdale, Wayne Turl, and Tom Smith generously summarized their observations.

The pilots and crew of the Carrier Antisubmarine Air Groups 53 and 59, Bruce Mate and Jamie and Skeeter Forbes made the aerial observations possible.

Michelle White and Debbie Weitl typed the various drafts of the manuscript.

LITERATURE CITED

Busnell, R. G. 1973. Symbiotic relationship between man and dolphins. N.Y. Acad. Sci. Trans. Ser. II, 35:112-131.

Caldwell, D. K. 1955. Evidence of home range of an Atlantic bottle-nose dolphin. J. Mammal. 36:304-305.

Caldwell, D. K., and M. C. Caldwell. 1972. The world of the bottle-nosed dolphin. J. B. Lippincott Co., Phila. and N.Y., 157 p.

Caldwell, M. C., D. K. Caldwell, and W. E. Evans. 1966. Sounds and behavior of captive Amazon fresh-water dolphins, *Inia geoffrensis*. Los Ang. Cty. Mus., Contrib. Sci. 108, 24 p.

Evans, W. E. 1973. Echolocation by marine delphinids and one species of fresh-water dolphin. J. Acoust. Soc. Am. 54:191-199.

Green, R. E., W. F. Perrin, and B. P. Petrich. 1971. The American tuna purse seine fishery. *In* H. Kristjonsson (editor), Modern fishing gear of the world: 3, p. 182-194. Fishing News (Books) Ltd., Lond.

Gunter, G. 1938. Seasonal variations in abundance of certain estuarine and marine fishes in Louisiana, with particular reference to life histories. Ecol. Monogr. 8:313-346.

_____. 1942. Contributions to the natural history of the bottle-nose dolphin, *Tursiops truncatus* (Montague), on the Texas coast, with particular reference to food habits. J. Mammal. 23:267-276.

_____. 1951. Consumption of shrimp by the bottle-nosed dolphin. J. Mammal.32:465-466.

_____. 1954. Mammals of the Gulf of Mexico. *In* P. S. Galtsoff (coordinator), Gulf of Mexico, its origin, waters, and marine life, p. 543-551. U.S. Fish Wildl. Serv., Fish. Bull. Vol. 55.

Harris, J. C. 1938. Porpoises feeding. Life. 5(12):67.

Herald, E. S., R. L. Brownell, Jr., F. L. Frye, E. J. Morris, W. E. Evans, and A. B. Scott. 1969. Blind river dolphin: First side-swimming cetacean. Science 166:1408-1410.

Hideyuki, H., H. Mako, K. Okada, and U. Yamada. 1969. On the stomach contents of dolphins and porpoises off Kyushu. [In Jap., Engl. abstr.] Bull. Seikai Reg. Fish. Res. Lab. 37:71-85.

Hoese, H. D. 1971. Dolphin feeding out of water in a salt marsh. J. Mammal. 52(1):222-223.

Hunter, J. R. 1968. Fishes beneath flotsam. Sea Front. 14:280-288.

Kemp, R. J. 1949. Report on stomach analysis from June 1, 1949 - August 31, 1949. Annu. Rep. Mar. Lab. Tex. Fish Game, Oyster Comm. for the fiscal year 1948-1949, p. 111-112, 126-127.

Kleinenberg, S. E. 1938. Quelques donnees sur l'alimentation de *Tursiops truncatus* fabr. dans la Mer Noire. Bull. Soc. Nat. Moscou 47: 406-413.

Klima, E. F., and D. A. Wickham. 1971. Attraction of coastal pelagic fishes with artificial structures. Trans. Am. Fish. Soc. 100:86-99.

Layne, J. N., and D. K. Caldwell. 1964. Behavior of the Amazon dolphin, *Inia geoffrensis* (Blainville), in captivity. Zoologica (N.Y.) 49:81-108.

Leatherwood, S., and M. W. Platter. 1975. A preliminary assessment of summer stocks of bottle-nosed dolphins, *Tursiops truncatus*, in coastal waters of Alabama, Mississippi, and eastern Louisiana. J. Wildl. Manage. (in review).

Leatherwood, J. S., and W. F. Samaras. 1974. Some observations of killer whales, *Orcinus orca*, attacking other marine mammals. Proc. South. Calif. Acad. Sci. meeting, Fullerton, California, 1974.

Norris, K. S., and J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican Waters. Univ. Calif. Publ. Zool. 63:291-401.

Teal, J., and M. Teal. 1969. Life and death of the salt marsh. Atlantic Monthly Press, Boston.

Townsend, C. H. 1914. The porpoise in captivity. Zoologica (N.Y.) 1:289-299.

True, F. W. 1885. The bottle-nose dolphin, *Tursiops tursio*, as seen at Cape May, New Jersey. Science (Wash., D.C.) 5:338-339.

MFR Paper 1157. From Marine Fisheries Review, *Vol. 37, No. 9, September 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1158

Laboratory Evaluation of a Denil-Type Steeppass Fishway with Various Entrance and Exit Conditions for Passage of Adult Salmonids and American Shad

EMIL SLATICK

*ABSTRACT—This research was designed to determine the feasibility of using a Denil-type fishway as part of a system to trap marked adult salmon and trout ascending a pool-and-overfall fishway at Little Goose Dam on the Snake River. Several entrance and exit situations were tested along with two methods (hollow weir and a pool) of supplying water to the Denil. Water supplied directly to the Denil through a hollow weir provided the best passage conditions for chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), steelhead trout (*Salmo gairdneri*), and American shad (*Alosa sapidissima*). Salmonids and shad readily entered and ascended a Denil fishway when the downstream end was submerged to a depth of 2.5 feet (0.7 m). Chinook salmon, coho salmon (*O. kisutch*), and steelhead trout readily passed through a Denil steeppass fishway that was 50 feet long (15.2 m) and positioned at a slope of 28.7 percent.*

INTRODUCTION

Denil steeppass fishways (Ziemer, 1962) have been used successfully in Alaska (Ziemer, 1965) to pass adult migrating pink salmon (*Oncorhynchus gorbuscha*), sockeye salmon (*O. nerka*), and coho salmon (*O. kisutch*). This type of fishway has the advantage of being portable, is relatively inexpensive, and can pass a substantial number of fish per unit of time.

Experiments on slopes of Denil steeppass fishways[1] at the Fisheries-Engineering Research Laboratory at Bonneville Dam indicated that salmonids ascending pool-and-overfall fishways in the Columbia and Snake Rivers would also pass through a Denil fishway.

The National Marine Fisheries Service (NMFS) (formerly the Bureau of Commercial Fisheries) has been conducting research for several years in an effort to find solutions to the complex fish passage problems caused by dams on the Columbia and Snake Rivers. Since 1968 considerable effort has been centered on transportation experiments designed to determine whether collecting juvenile salmonid migrants at upstream dams and transporting them downstream around hazardous areas, such as turbines at dams, might be a feasible method of reducing losses during downstream migration. Evaluation of these studies is based on returning adults.

To properly evaluate these experiments, an automatic system was needed to detect and separate wire-tagged (Jefferts et al., 1963) adult salmon during ascent of a fishway. Durkin et al. (1969) described and tested a prototype system at Minter Creek Hatchery, and Ebel et al. (1973) used this system successfully in the fish ladder at Ice Harbor Dam to evaluate a transportation experiment. A basic requirement of the detection system is that the fish must pass the detector head at a velocity of about 1.0 m/s. This can be achieved in a conventional fishway by directing the fish to an auxiliary steeppass which requires ascent to a height above the primary fishway. On reaching the apex of the steeppass, the fish descend a chute which discharges them past the detector head at the required velocity. Untagged fish are returned directly to the primary fishway, whereas tagged fish are automatically deflected into a holding trap.

Another transportation experiment is presently in progress at Little Goose Dam on the Snake River, and a comparable automatic detection and separation system was needed for pickup of wire-tagged adult salmon. Although the detection and collection system used at Ice Harbor incorporated a steeply sloped pool-and-overfall fishway, space limitations in the fishway at Little Goose Dam precluded use of a pool-type fishway. However, previous experiments at the Fisheries-Engineering Research Laboratory on slopes of Denil steeppasses indicated that a Denil fishway would be suitable for adaptation at Little Goose Dam.

Before installing the Denil in the fishway at Little Goose Dam, we needed to know its effect on fish passage. Therefore, in 1971, we conducted experiments with the Denil fishway to determine the best entrance and exit conditions and to assess the affect on fish passage through the Denil when placed in a prototype 1-on-10-slope, pool-and-overfall fishway. This information is described herein and was used in the final design of the automatic detection and separation system installed at Little Goose Dam.

EQUIPMENT AND PROCEDURES

This study was conducted at the Fisheries-Engineering Research Laboratory located at Bonneville Dam on the Columbia River (Collins and Elling, 1960). The laboratory is an enclosed rectangular flume 180 feet (54.9 m) long, 24 feet (7.3 m) wide, and 24 feet (7.3 m) deep, located adjacent to the Washington shore fish ladder on the

[1]Weaver, C.R. Progress Report No. 154 for January through March 1969. Research on fishway problems conducted at the Fisheries-Engineering Research Laboratory at Bonneville Dam under Contract No. DA-35-026-25142 with the U.S. Fish and Wildlife Service (Biol. Lab., Seattle, Wash.). 8 p. (Typescript.)

Emil Slatick is a member of the staff of the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112.

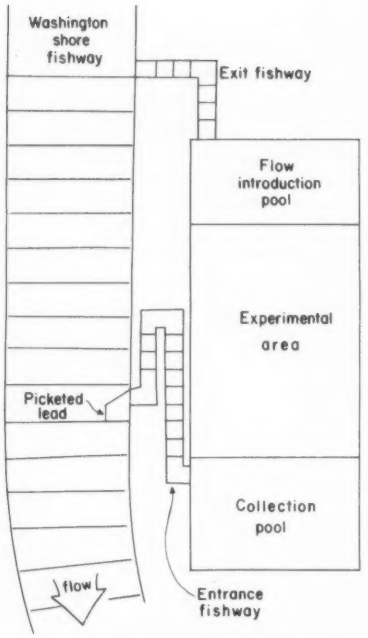


Figure 1.—Plan view of Fisheries-Engineering Research Laboratory showing relationship to the Washington-shore fishway at Bonneville Dam.

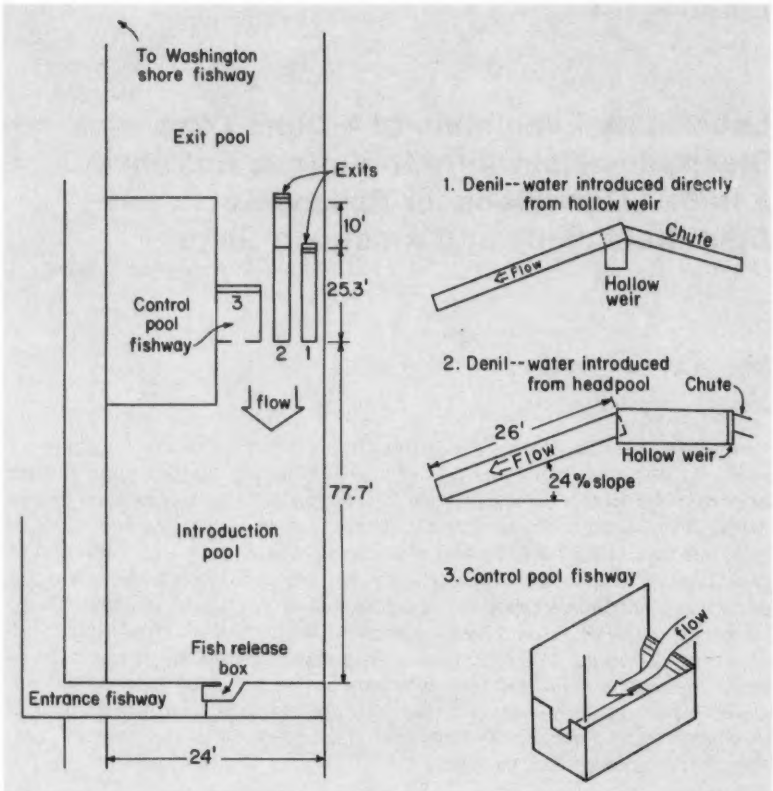


Figure 2.—Plan view of experimental area used for tests of entrance and exit conditions of Denil-type fishways.

north bank of the river (Fig. 1). Fish were diverted from the ladder and observed as they passed on their own volition through experimental conditions in the laboratory. After attaining the upstream pool they reentered the ladder and continued their migration over the dam. Fish were not handled at any time.

Illumination throughout the tests was provided by 1,000-watt, mercury-vapor lights, spaced at 6-foot (1.8-m) intervals and placed 6 feet (1.8 m) above the water. These lights provided an intensity of illumination comparable to that in the main Bonneville fishway on a bright, cloudy day.

The laboratory provided the capability for testing the performance of fish over a range of operational conditions in the Denil fishway. Figure 2 is a plan view of the experimental area within the laboratory. Facilities in this area consisted of a submerged release box, a large introductory pool and—depending on the experiment—a Denil fishway, a pool-and-overfall fishway, or both.

Fish used in these experiments entered the experimental area through the release box where an observer ascertained size and species. The fish then passed through the introductory pool, through one of the experimental fishways, and into an exit pool from which it reentered the Washington shore fishway and continued its ascent over the dam.

The experimental structures consisted of a Denil fishway and a pool-and-overfall fishway. The Denil fishway used in this study was a steep-pass model A described by Ziemer (1962). This is an aluminum flume made of 10-foot (3.1-m) long sections that are 22 inches (0.5 m) wide by 27 inches (0.7 m) high and contain internal baffles for control of water velocity (Fig. 3). Clearance within the baffles (open area) is 14 inches (0.35 m) by 22 inches (0.6 m). Sections were bolted together to achieve length of ladder required for testing. During the experiments the Denil was completely filled with water and carried a flow of approximately 5.5 cfs (0.16 m^3).

A simple control fishway used in these tests was positioned adjacent to the Denil structure and consisted of a single pool having dimensions identical to those in the auxiliary pool-type fishway at Ice Harbor Dam. The pool

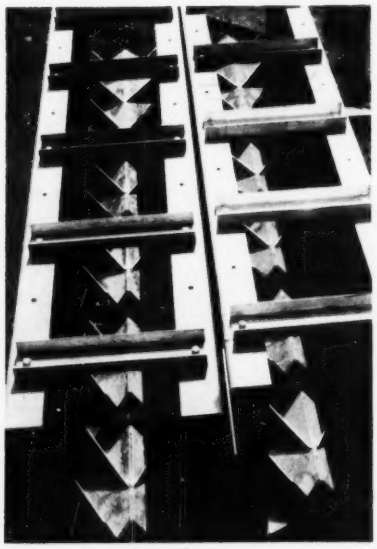


Figure 3.—Sections of model A Denil fishways.

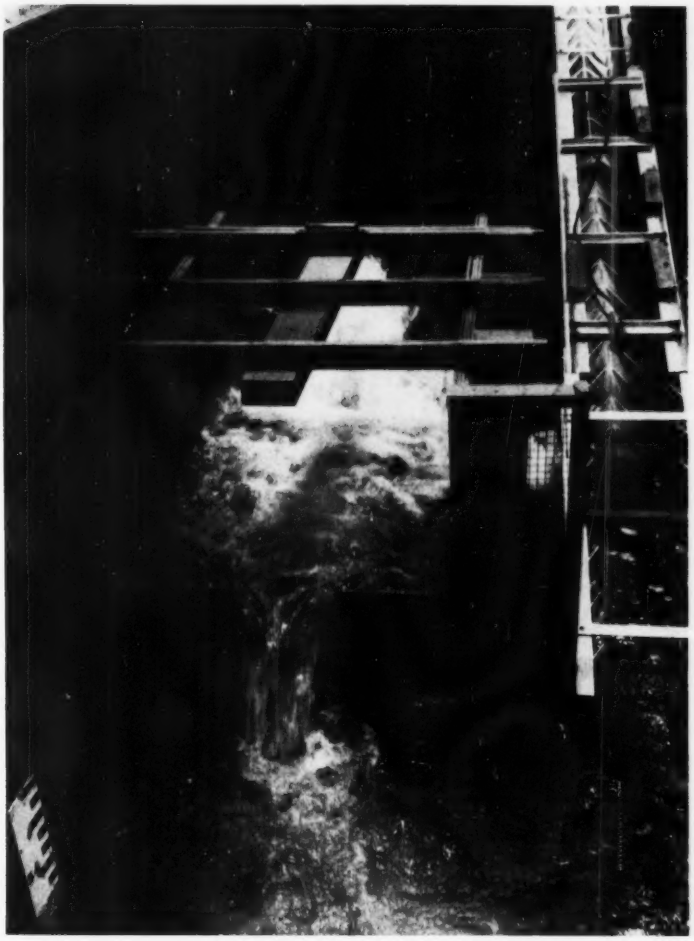


Figure 4.—The control pool-type fishway in operation. Structure on the right is an unwatered Denil fishway.

was 4 feet (1.2 m) wide, 8 feet (2.4 m) long, and 6 feet (1.8 m) deep. Water entered from a hollow weir at the upstream end and filled the pool to a depth of 3.7 feet (1.2 m). Discharge from the pool was through a notched weir (Fig. 4) and totaled 2.5 cfs (0.07 m^3).

Due to poor visibility at the entrance into the Denil fishway (caused by turbidity and large amounts of entrained air in the water), fish could not be enumerated as they entered. Instead, fish were timed as they entered the introductory pool and as they exited over the hollow weir at the upstream end of the Denil fishways. Timing of fish in the control, pool-and-overfall fishway was from time of release until entry to the fishway. Thus, passage times recorded for the test conditions (Denil) were for transit through the entire system, whereas those for the control (pool-type fishway) covered only the period from release into the system to entry of the fishway.

A time-event recorder was used to log fish passage through the test area. Observers at the release and exit points activated push-button switches to transmit information to the recorder. This information was then transcribed onto an operations sheet.

Our study consisted of a series of tests which can be grouped into three categories. The first series evaluated various entrance and exit conditions of the Denil fishway and also compared fish passage in the Denil fishway system with that in the pool-and-overfall fishway. The second series was concerned with assessments of fish passage in a selected Denil system installed in a prototype 1-on-10-slope fishway. The third series involved evaluations of fish passage through a 50-foot (15.2-m) long Denil fishway.

Two experiments were conducted to determine the effect of entrance conditions on fish passage through a Denil fishway system. In the first we evaluated three types of entrance conditions, and in the second we compared the response of fish presented with a choice of entering a Denil or pool-type fishway. The Denil fishway in these tests was 26 feet (7.9 m) long and inclined at a slope of 24 percent.

Entrance conditions tested included the following:

1. Downstream end of the Denil submerged to the top of the entrance of the Denil fishway (Fig. 5A) with wire mesh leads (Fig. 6) at the entrance to guide fish into the fishway.

2. Same as number 1 except that downstream end was extended 10 feet (Fig. 5B) so that top of Denil entrance was submerged 2.5 feet (0.8 m). Screened sides were added to this submerged section to retain fish within confines of the Denil fishway, and space bars in the submerged section were removed to facilitate fish passage into the fishway.

3. No lead or side screens at entrance to Denil. With these screens removed, fish could proceed 10 feet (3.1 m) farther upstream until they were stopped by the upstream barrier screen (Fig. 5C).

In the second experiment on entrance conditions, a Denil-type fishway and the control pool were offered simultaneously to determine the preference of salmonids and shad when offered a choice of entering a Denil fishway or a pool-and-overfall fishway (Fig. 7).

Tests of exit conditions for fish passage through the Denil fishway systems were concerned with the means by which water was discharged into the Denil fishway and effects of these water supply systems on fish passage. Three exit conditions were examined for their effect on fish passage. In addition, passage through the Denil systems was compared with that in the control pool-and-overfall fishway. Exit conditions tested in replicate included the following:

1. Flow from hollow weir (Fig. 8) discharged directly into Denil fishway. Standing water depth at the upstream end of the weir was from 10

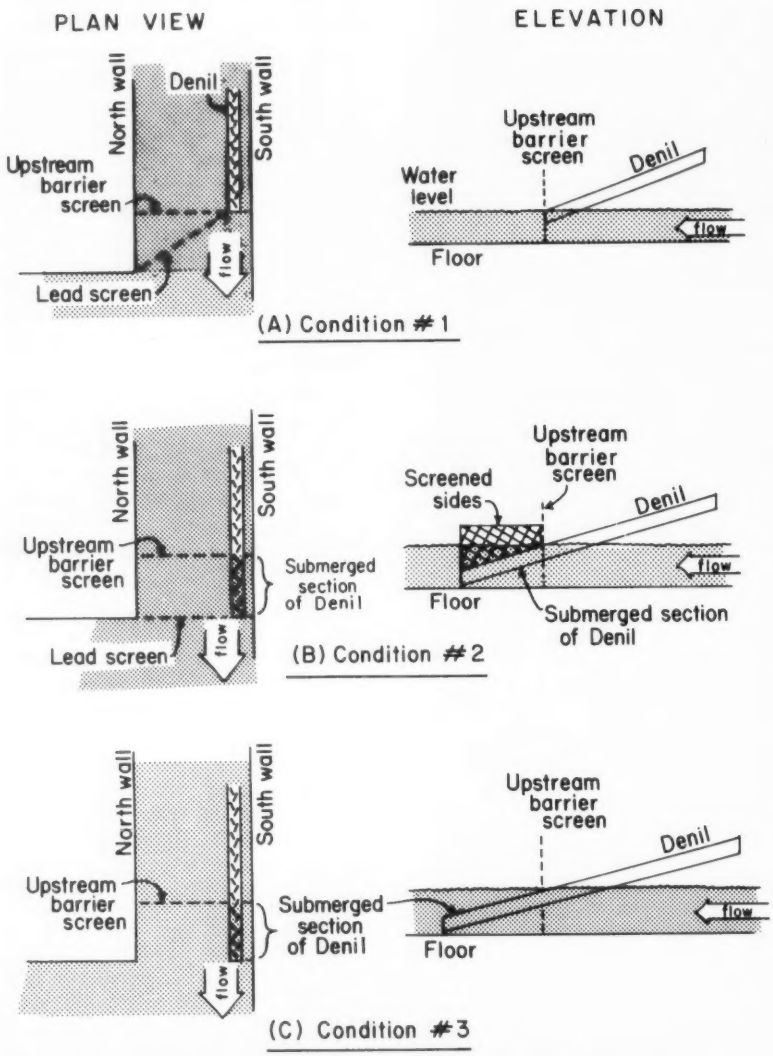


Figure 5.—Plan and side view of experimental area showing position of Denil for entrance condition tests.

Figure 6.—The Denil fishway in operation with wire mesh lead screens situated to guide fish to the entrance of the fishway.

to 12 inches (0.25 to 0.31 m); most of the water entered the Denil, but a small quantity spilled into the chute to sluice fish back to water level of the laboratory exit pool. Fish swam through the Denil, over the top of the hollow weir, and their momentum carried them directly into the chute (Fig. 9).

2. Flow to Denil fishway from a headpool supplied by water plunging from a hollow weir at upstream end of pool. Headpool dimensions were 10 feet (3 m) long by 2 feet (0.6 m) wide by 5 feet (1.5 m) high. Fish passed from Denil to headpool and then over hollow weir into chute. Plexiglas[2] windows on a sidewall provided a view of the fish during passage through the pool. Water depth in headpool was 3 feet (0.9 m); flows passed over lip at downstream end of pool and into Denil fishway.

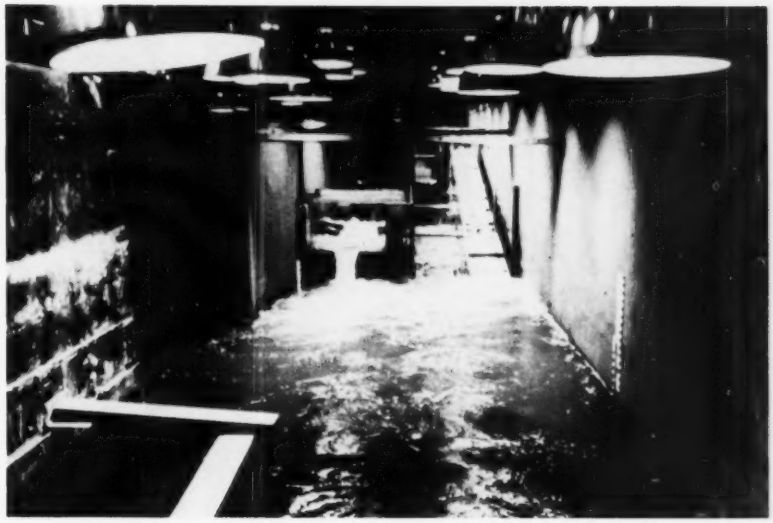
3. Same conditions as in 2 above except that an inclined grill was installed on downstream face (Fig. 10) of the hollow weir. Water supplied to the laboratory and used in the hollow weirs during tests was by gravity flow from the Bonneville Dam forebay.

Tests involving the installation of a Denil fishway within a section of a 1-on-10-slope fish ladder (Fig. 11) were done to determine the effect on fish passage. Water supplying the Denil and various structural modifications within the pool fishway that were necessary to install the Denil could disrupt fish passage. The Denil fishway in these tests was 30 feet (9.1 m) long and inclined at a slope of 28.7 percent. Flow to the Denil was supplied through a hollow weir. Three operating conditions (Fig. 12) were tested to determine which would be preferable for use at Little Goose Dam. They were:

1. Gravity flow to the Denil steeppass from source outside the pool-type fishway. This condition caused a 0.2-foot (6.1-cm) rise in pool levels downstream from the Denil. (In the above tests, weir 545 immediately downstream from the Denil was removed to provide a long approach pool to the entrance of the steeppass.)

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 7.—Simultaneous operation of Denil fishway (right side) and control pool-type fishway (left side). Portion of introductory pool in foreground.



2. Flow to the Denil steeppass pumped from the 1-on-10 fish ladder. No change resulted in water level of pools downstream from the Denil (in the above tests, weir 545 immediately downstream from the Denil was removed to provide a long approach pool to the entrance of the steeppass).

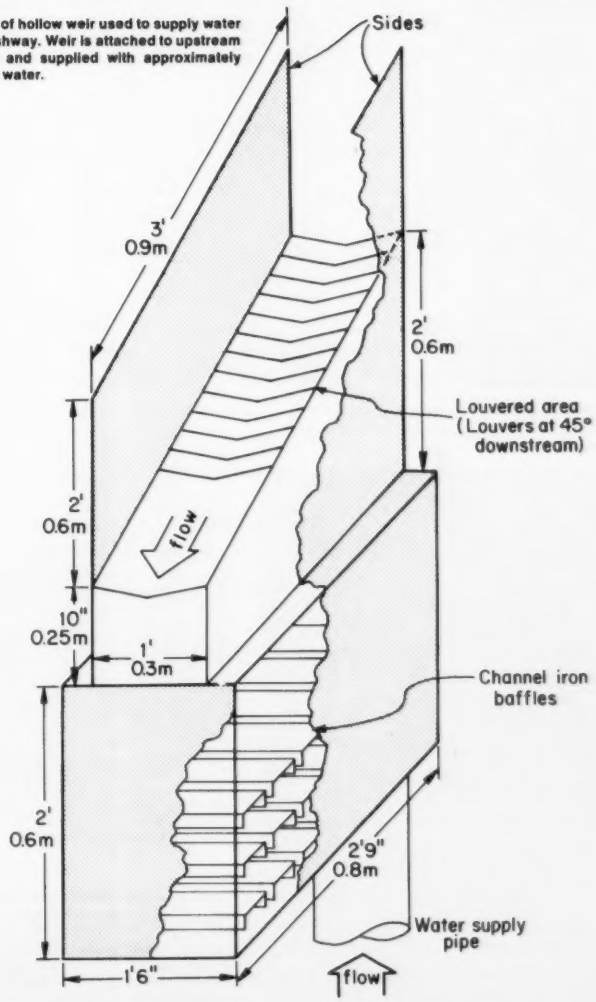
3. Same as condition one except that a stub weir (half-height) was installed in the pool-and-overfall fishway immediately downstream from the Denil. A capacity test was conducted under this condition to determine the maximum number of fish that would pass through the Denil fishway system.

The final design selected for installation at Little Goose Dam required two 50-foot (15.2-m) long Denil fishways. To achieve that length in the laboratory, we added a 20-foot (6.1-m) section to the downstream end of the existing steeppass. This placed the bottom of the downstream end of the Denil on the floor of the laboratory. Water depth at the approach to the Denil was, therefore, only about 2.5 feet (0.7 m).

Fish used in these tests are designated as spring-, summer-, and fall-run salmonids and American shad (*Alosa sapidissima*). Spring runs consisted of chinook salmon (*O. tshawytscha*) and steelhead trout (*Salmo gairdneri*); summer runs consisted of chinook salmon, sockeye salmon, and steelhead trout; fall runs consisted of chinook salmon, coho salmon, and steelhead trout. Other species of fish which passed through the Denil fishways included suckers (*Catostomus* sp.); northern squawfish (*Ptychocheilus oregonensis*); and Pacific sea lamprey (*Entosphenus tridentatus*).

Fish used in the first series of experiments on entrance and exit conditions consisted of spring- and summer-run salmonids and American shad. These fish were actively migrating adults and ranged in size from 8 to 39 inches (20 to 100 cm). Our test procedure was to release 25 chinook salmon and any other fish which voluntarily entered the test area during the time the chinook entered. Then the release of fish was stopped and 1 h was allowed for the fish to pass through the test area. This arbitrary time limit was established so

Figure 8.—Details of hollow weir used to supply water directly to Denil fishway. Weir is attached to upstream end of the Denil and supplied with approximately 5.5 cfs (0.16m³) of water.



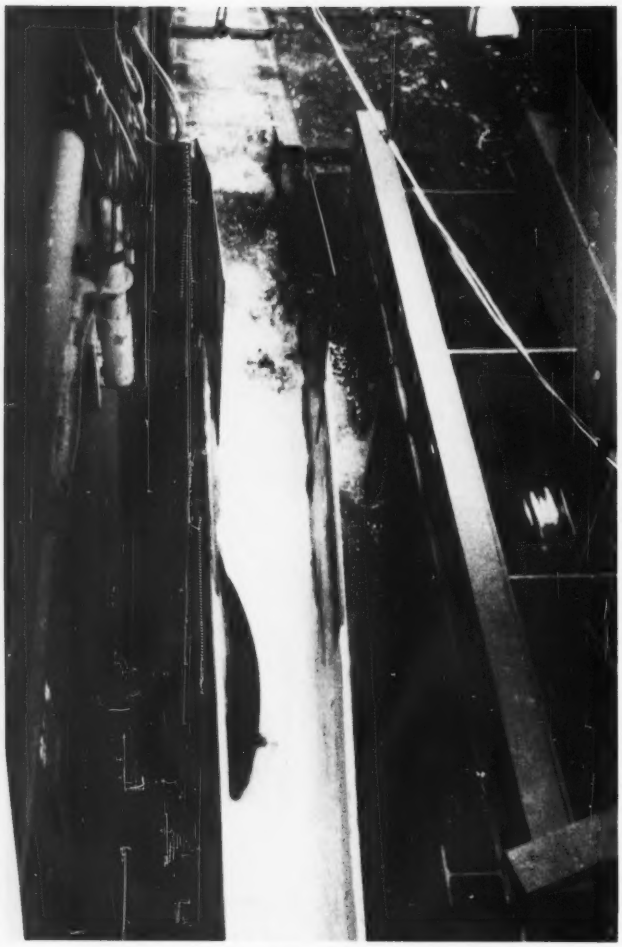


Figure 9.—Adult salmon after passing apex of hollow weir slides down to base water level.

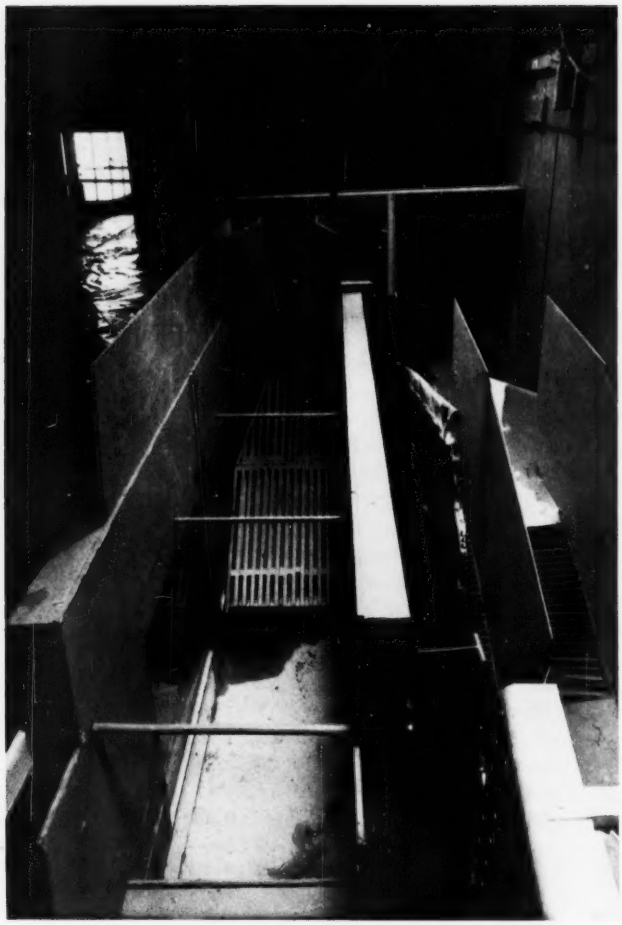


Figure 10.—Headpool showing inclined wooden grill on downstream face of hollow weir (center). Hollow weir without grill and without headpool on right.

Figure 11.—Flow conditions in mockup of Denil fishway in 1-on-10 slope fish ladder. In lower foreground is a portion of the introductory pool; in the center are two fish ladder pools downstream from the Denil. Entrance to the Denil fishway is at upper right. Picket lead for directing fish to Denil appears on left of entrance to Denil.

that excessive time would not be spent on fish that failed to pass through the test facility.

Our second series of tests with the Denil fishway in a prototype 1-on-10-slope fish ladder was conducted with fall-run fish. The procedure was to release fish for 2 h and allow 1 h for the fish to pass through the test area. Fish for the capacity test were collected below the test area for 6 h; then a large gate was opened allowing the massed fish free entry into the test area. The same procedure as above was used in regard to time limits.

For the third series of tests where fish passage through a 50-foot (15.2-m) long Denil was examined, we also used fall-run salmonids. Fish were released into the test area as rapidly as available for 1 h and 15 min, after which 1 h was allowed for the fish to pass through the test area.

Evaluation of fish performance was made by comparing passage time and the proportion of fish completing passage within a given time period. The statistic "median elapsed time" was used to compare passage time of groups of fish passing through the fishways. This was determined by subtracting the time of the median fish at the release box from the time of the median fish at the exit of the Denil fishways. Timing through the control structure was determined by subtracting the time of

the median fish at the release box from time of the median fish entering the control pool.

SALMONID PERFORMANCE IN DENIL FISHWAYS

Salmon and steelhead trout entered and passed through all fishway systems examined. Differences in performance of fish were observed, however, among the various entrance and exit conditions.

Effect of Entrance Conditions

The use of fishway entrance leads and the submergence of the Denil entrance affected the passage of summer salmonids through a Denil fishway system. When offered a normal Denil entrance condition (Denil not submerged but fishway leads provided), 96 percent of the salmonids passed through this system in 12 min (Fig. 13). When summer salmonids were offered the submerged Denil entrance provided with fishway lead screens, they accepted and passed through the Denil but at a slower rate of speed. The median elapsed passage time increased to 27.5 min.

When the fishway lead screen and screened sides on the submerged portion of the Denil were removed, the proportion of fish entering and passing through the Denil fishway during the test period decreased; only 75 percent of the summer salmonids passed through the Denil fishway system (Fig. 13) and the length of time required to enter and pass through the test facility increased to 37 min. Obviously, the lead screen and screened sides were beneficial in enhancing the entrance to the Denil fishway.

Response of spring and summer salmonids presented with a choice of entering a Denil or a pool-type fishway was very clear-cut. Seventy percent of the spring salmonids chose the Denil and 30 percent chose the pool-and-overfall fishway (Fig. 14). When summer salmonids were offered this choice, 97 percent selected the Denil and only 3 percent entered the pool fishway.

These results are very similar to those obtained by Fulton et al. (1953) at Dryden Dam on the Wenatchee River. The Denil used by Fulton had 40 percent more flow than his pool-type fishway. Enumeration of the fish run showed that 89 percent of the salmonids chose the Denil and 11 percent chose the pool-type fishway.

The Denil we used carried 55 percent more water than the pool fishway.

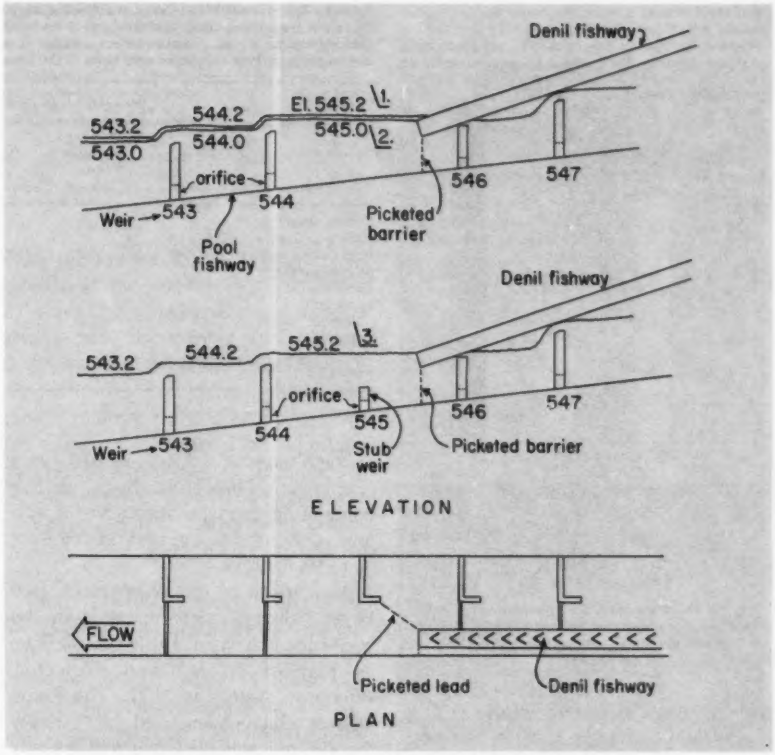


Figure 12.—Plan and elevation views of prototype fishway. Plan view illustrates the layout of three test conditions. Elevation view shows the location of the Denil in the pool fishway.

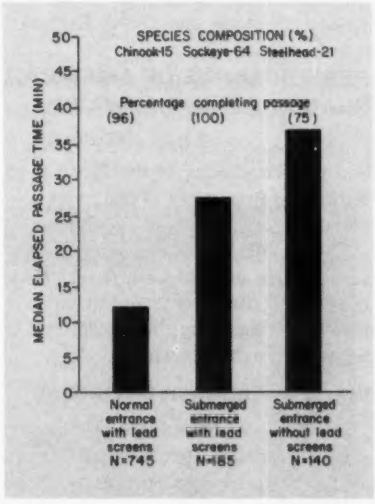


Figure 13.—Effect of entrance conditions of Denil fishways on passage time of summer-run salmonids through a Denil fishway.

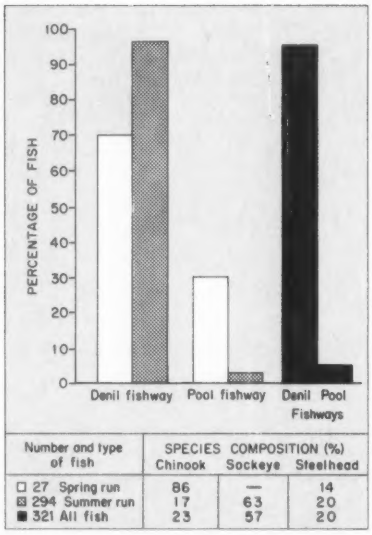
If we combine our spring and summer salmonid passage data, the results indicate that 95 percent of the salmonids chose the Denil and only 5 percent selected the pool-type fishway.

Effect of Exit Conditions

The best exit condition for passage of both spring- and summer-run salmonids (11.5 and 12.0 min, respectively, Table 1) was provided by the Denil fishway with flow supplied directly from a hollow weir. In contrast, passage into the control (pool) fishway took longer (73 and 86 min for spring- and summer-salmonids, respectively). The proportions of salmonids completing passage ranged from 100 percent in the Denil to 73 percent in the control fishway.

Evaluation of Prototype Denil Fishway Installation

There was little difference in the passage times of fall-run salmonids through the Denil fishway under the three simulated operating conditions tested in a section of a pool fishway.



Number and type of fish	SPECIES COMPOSITION (%) Chinook	Sockeye	Steelhead
□ 27 Spring run	86	—	14
▨ 294 Summer run	17	63	20
■ 321 All fish	23	57	20

Figure 14.—Response (i.e., percentage of the total number of fish that entered each fishway) of salmonids presented with a choice of entering a Denil or a pool-type fishway.

The median elapsed passage times under the two conditions with the first downstream weir completely removed were: 17.7 min with an outside water source and 14.0 min with pumped water. The median elapsed passage time with the outside water source and a half weir downstream of the Denil was 11.5 min (Fig. 15).

The best passage situation (Denil fishway supplied by an outside water source and a half weir downstream) was used to examine the fish-passing capacity of a Denil fishway with prototype dimensions. Four hundred and two fish passed through the Denil during the capacity test. Peak passage for a 20 min period averaged 11 fish per min, and peak passage for a 1 min period was 19 fish per min (Table 2). Thus, we estimated that the fish-passage capacity of the proposed installation would most likely fall within a range of 650 to 1,140 fish per hour during peak passage times.

Effect of a 50-foot (15.2-m) Long Denil on Fish Passage

Extending the Denil fishway an additional 20 feet (6.1 m) for a total length of 50 feet (15.2 m) had no adverse affect on passage efficiency. The results of three separate tests using fall-run salmonids indicated median elapsed passage times of 4.0, 6.5, and 10.2 min (Table 3). The proportions of fish completing passage through the test area within the test period ranged from 90 to 93 percent.

As a result of this experiment, two Denil fishways were installed in the pool-type fishway at Little Goose Dam as part of an automatic detector-separator system in 1972. The Denil fishways have been used successfully for 3 years and pass fish without any apparent injuries or noticeable delay. During this time approximately 160,000 adult migrating salmon and 110,000 steelhead trout have ascended and passed through the Denil fishways.

Table 1.—Comparison of fish passage in the Denil fishway facility with that in the control (pool fishway). Passage times and proportions completing passage in the Denil structure include fish performances from time of release (into introductory area downstream from fishway) to exit from the fishway. Those for control include only movement from time of release until entry to the control pool.

Test condition	Spring-run salmonids: No. of fish	Median passage time (min)	Completed passage (%)	Summer-run salmonids: No. of fish	Median passage time (min)	Completed passage (%)
Source water directly to Denil—from hollow weir	132	11.5	100	745	12.0	96
Source water to Denil—from headpool						
Without grill	59	34.0	86	312	30.0	100
With grill	69	33.0	95	330	21.0	99
Control (pool fishway)	67	50.0	73	345	47.5	86

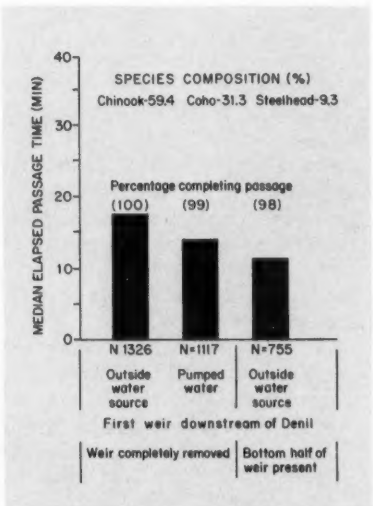


Figure 15.—Comparison of median elapsed time and proportions of fall-run salmonids passing through a Denil fishway system placed in a 1-on-10 slope pool and overfall fishway under three simulated operating conditions.

PERFORMANCE OF AMERICAN SHAD IN DENIL FISHWAYS

The response of shad to the entrance and exit conditions of the Denil used during the first series of tests was also examined. The timing of shad migration at Bonneville Dam precluded an examination of shad response to the prototype Denil that was tested in the fall; thus data regarding their response to the prototype are lacking.

Effect of Entrance Conditions

Entrance conditions affected the passage of shad through a Denil fishway system. Under the normal entrance conditions (with only the entrance to the Denil submerged and fishway lead screens present), 32 percent of the shad passed through the system in 47 min. When the entrance was submerged to a depth of 2.5 feet (0.8 m) and was equipped with screened sides and fishway leads, 61 percent of the shad entered and passed through the Denil fishway system in 54 min. Removal of

Table 2.—Summary of a fish passage test to determine capacity of a prototype fishway installation containing a 30-foot (9.1-m) long Denil fishway set at a slope of 28.7 percent, 13 September 1971.

Total no. fish entered	Numbers of fish passed: Total passage (1 h)	60-min period (avg. per min)	Peak 20 min period	Peak 1 min period	Species composition (%): Chinook salmon	Coho salmon	Steelhead trout
412	402	6.7	10.8	19	54	27	19

Table 3.—Passage times and the proportions of three groups of fish which ascended a 50-foot (15.2-m) long Denil fishway with a slope of 28.7 percent, 16 September 1971.

Test group	No. of fish entering fishway	No. of fish exiting fishway	Completed passage (%)	Median elapsed passage time (min)	Species composition (%)		
					Chinook salmon	Coho salmon	Steelhead trout
1st	69	62	90	6.5	43	42	15
2nd	86	80	93	4.0	55	34	11
3rd	83	76	92	10.2	44	41	15

the lead screens and screened sides on the submerged portion of the Denil decreased the proportion of fish entering and passing through the Denil fishway during the test period. When this was done, only 20 percent of the shad passed through the Denil fishway. Obviously, the submerged entrance with lead screens and screened sides was beneficial in enhancing entrance to the Denil fishway for shad.

Response of shad when presented with a choice of entering a Denil or a pool-type fishway was also obvious. Of the 109 shad introduced into the test area, 35 (32 percent) entered and passed through the Denil; none entered into the pool-type fishway.

Effect of Exit Conditions

Exit conditions had a very definite effect on the passage of shad through the Denil fishway systems. Of the four fishway systems tested, the best exit condition for shad passage was provided by the Denil fishway supplied with a direct flow from a hollow weir. Under this condition 32 percent of the shad introduced in the test area entered and passed through the Denil fishway. Their median elapsed passage time was 47 min (Table 4). Although shad passed through the Denil fishway supplied with flow from a headpool, they would not exit the headpool (Fig. 16). Thus, this method of supplying the Denil would not be feasible for passage of shad. Shad failed to enter the pool-type (control) fishway; exit condition of this system therefore had no effect.

Observations of shad behavior in the headpool indicated that shad did not continue upstream principally because of the exit condition created by the weir supplying the pool. This condition was similar to that found in the pool-type (control) fishway. Shad were often seen swimming up to the overfall flow from the weir, where they would assume the typical exit position (as used by salmonids, Fig. 17), and remain in that position for a time. Later they turned and dropped back to the lower downstream half of the headpool and eventually passed back downstream through the Denil.

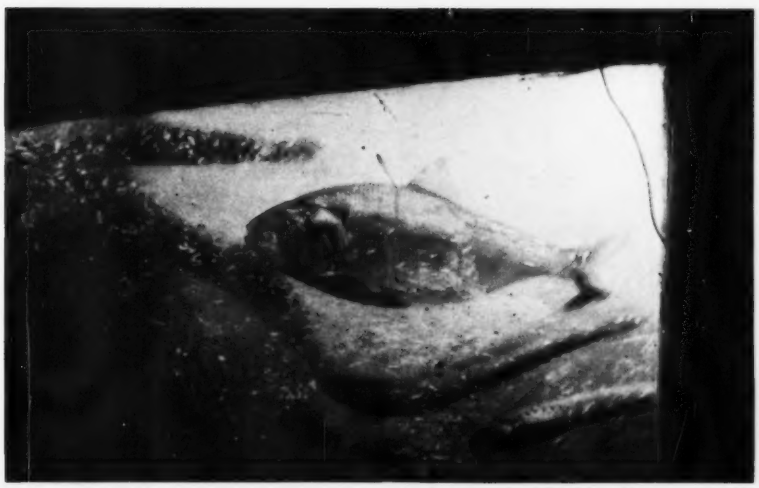


Figure 16.—View of downstream half of headpool through Plexiglas window. Note shad resting in headpool.

Table 4.—Comparison of passage of American shad in the Denil fishway facility with that in the control (pool fishway). Passage times and proportions completing passage in the Denil structure include fish performances from time of release (into introductory area downstream from fishway) to exit from the fishway. Those for the control include only movement from time of release until entry to the control pool.

Test condition	No. of fish	Median passage time (min)	Percentage of fish completing passage
Source of water to Denil from hollow weir	180	47.0	32
Source of water to Denil from headpool	52	84.0	2
Control (pool-fishway)	154	55.0	1

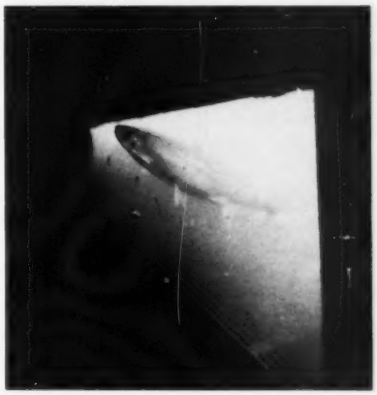


Figure 17.—View of upstream half of headpool through Plexiglas window. Fish in center has assumed a typical exit position in front of the hollow over-flow weir. Wooden inclined grill can be seen in lower left side of window.

Effect of Test Period Duration on Shad Passage

To determine whether the arbitrary 1 h limit was sufficient to assess completed passage by shad, we extended this time limit to 2- and 3-h periods. The results indicated that the length of the test period was one of the limiting factors on the proportions of shad which completed passage through the Denil fishway system. The proportions of shad completing passage through the Denil (with a direct flow from a hollow weir) increased from 32 percent in a 1-h period to 54 percent in a 2-h period and 61 percent in a 3-h period.

Even though the proportion of shad passing through the Denil fishway was considerably less than that of salmonids under all conditions, the tests indicated that shad will enter and ascend a Denil fishway if given sufficient time and the proper entrance conditions.

SUMMARY AND CONCLUSIONS

Tests were conducted at the Fisheries-Engineering Laboratory at Bonneville, Wash., to determine the desirability of using a Denil fishway within a primary pool fishway to direct fish into a tag detection and fish separating system designed to retrieve marked adult salmon and trout containing coded wire tags. Several design arrangements were set up and tested to determine which arrangement would provide the best fish passage with a minimum of delay. These tests included tests on the effect of lead screens, various methods of supplying flow, and length and slope of the Denil.

Initial tests indicated that salmonids and shad entered and passed faster through the Denil fishway with a flow directly from a hollow weir than through the Denil with a flow from a headpool, or through entrance into a pool-and-overfall fishway.

Salmonids and shad readily entered and ascended the Denil fishway when the entrance was submerged to a depth of 2.5 feet (0.8 m); best passage was attained when lead screens were used.

When offered a simultaneous choice between a Denil fishway and a pool-type fishway, the majority of the fish chose the Denil fishway.

Salmon and trout readily entered and passed through a Denil fishway at a 28.7 percent slope when it was placed in a mock-up of a 1-on-10-slope fish ladder of the type used at Little Goose Dam.

A capacity test indicated that 650 to 1,140 adult salmon and trout per hour can pass through a Denil fishway when it is placed in a 1-on-10-slope fish ladder.

Salmon and trout entered and passed through a 50-foot (15.2-m) long Denil fishway with no apparent difficulty.

Entrance and exit conditions were critical to shad passage through a Denil. Shad readily passed through a Denil fishway positioned at a slope of 24 percent when proper entry and exit conditions were provided.

Two 50-foot (15.2-m) long Denil fishways positioned at a slope of 28.7 percent installed at Little Goose Dam on the Snake River have passed approximately 273,000 adult salmon and trout.

ACKNOWLEDGMENTS

I am grateful to Robert Manis, NMFS, and Robert Holcomb, NMFS, retired, for their advice on the design and structural specifications used in the construction of this test facility.

LITERATURE CITED

Collins, G. B., and C. H. Elling. 1960. Fishway research at the Fisheries-Engineering Research Laboratory. U.S. Fish Wildl. Serv., Circ. 98, 17 p.

Durkin, J. T., W. J. Ebel, and J. R. Smith. 1969. A device to detect magnetized wire tags in migrating adult coho salmon. J. Fish. Res. Board Can. 26:3083-3088.

Ebel, W. J., D. L. Park, and R. C. Johnsen. 1973. Effects of transportation on survival and homing of Snake River chinook salmon and steelhead trout. Fish. Bull., U.S. 71:549-563.

Fulton, L. A., H. A. Gangmark, and S. H. Bair. 1953. Trial of Denil-type fish ladder on Pacific salmon. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 99, 16 p.

Jefferts, K. B., P. K. Bergman, and H. F. Fiscus. 1963. A coded wire identification system for macroorganisms. Nature (Lond.) 198:460-462.

Ziemer, G. L. 1962. Steeppass fishway development. Alaska Dep. Fish Game, Div. Eng. Serv., Inf. Leafl. 12, 36 p.

_____. 1965. Steeppass fishway development. Alaska Dep. Fish Game, Addenda to Inf. Leafl. 12, 5 p.

MFR Paper 1158. From Marine Fisheries Review, *Vol. 37, No. 9, September 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1159

An ancient fishing method brings twentieth-century anglers excellent results.

Night Stalking Flounder in the Ocean Surf

STANLEY M. WARLEN

INTRODUCTION

Spearing, probably the most ancient of fishing methods, is still practiced by contemporary commercial and sport fishermen. Javelins or spears used for self-protection and for hunting terrestrial animals were probably adopted for fish spearing as early as the upper Paleolithic period, more than 10,000 years ago (Znamierowska-Prüffer, 1966). About 8,000 years later, during the time of the Greeks and Romans, it was known that fish could be detected at night using an artificial light and then speared. Floyd (1966) described the modern day basic gear and technique of gigging (spearing) flounders in shallow protected coastal waters at night. The technique of stalking and gigging flounder while wading in the ocean surf at night with further descriptions of the gear employed are not recorded. The purpose of this report is to provide this documentation with emphasis on the methods and equipment typically used along the central North Carolina coast, south and west of Cape Lookout, and to acquaint fishermen with this novel type of surf fishing.

FISHING METHODS

Night stalking flounder in the ocean surf in North Carolina is done only in the fall of the year, September through November. It is then that flounders of the genus *Paralichthys* migrate from the estuaries to the ocean (Ginsburg, 1952). The first cold front or so-called "mullet blow" of the fall, characterized by decreasing air temperatures and northerly winds, usually signals the advent of flounder movement from the estuaries. After entering the ocean an unknown percentage of flounder move into the nearshore and surf zones where they stay, feeding on the abundant bait fishes, until about mid-November when the decreasing water temperature forces them to seek deeper water.

Figure 1.—Sport fisherman lifting a gigged flounder out of the surf and preparing to thread the fish on the stringer attached to the gig. (Photo courtesy of Curtis W. Lewis.)

Stanley M. Warlen is with the Atlantic Estuarine Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, NC 28516.

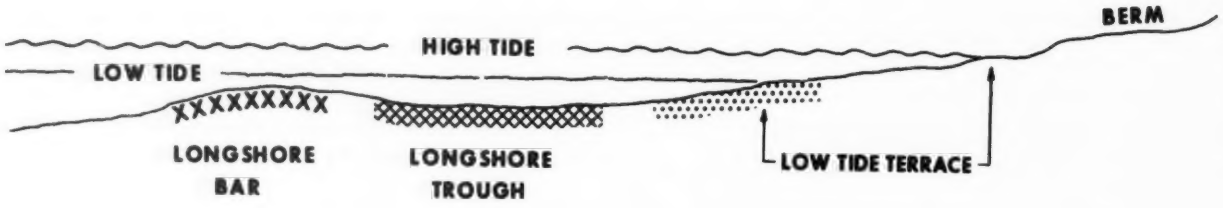


Figure 2.—Beach profile showing portions of the surf zone where flounder stalking is most productive at low tide (good indicated by cross hatching, best by x's) and at high tide (stippled).

General Technique

The basic technique is to wade in water waist-deep or shallower with an underwater light to search for flounders resting on or in the sandy bottom. When a fish is detected the stalker carefully readies his gig directly over the prey and with a quick thrust plunges the gig into the fish. Occasionally flounder may be seen swimming slowly over the bottom and may be gigged on the move. To minimize the damage to the edible portion of the fish, the stalker should attempt to strike the fish in the head region, preferably near the rear edge of the gill cover. After the fish ceases its struggle it is carefully lifted out of the water (Fig. 1) until it can be pushed up the metal gig (described later) and the gig point is threaded through the loop on the end of the stringer, thus securing the first fish. Fish caught subsequently are simply pushed down the stringer and are held on by the first fish. By putting fish on this type of stringer and dragging them along in the water, most of the fish may be kept alive during the fishing.

Flounders rely on their protective coloration and their ability to remain motionless on the bottom, partially or almost totally covered with sand, to capture food and evade predators. This concealment behavior is exploited by the stalker, who must simply search the bottom for an outline, fragmentary or complete, of a flounder. The stalker is aided by the blinding and possible mesmerizing effect that the artificial light has on the fish, as suggested by Znamierowska-Prüffer (1966).

Stringrays are occasionally encountered in the surf zone while searching for flounders. Virtually all of these rays are small and not aggressive and will very often swim away when the fisherman approaches. A few, however, do not and the fisherman should be alert.

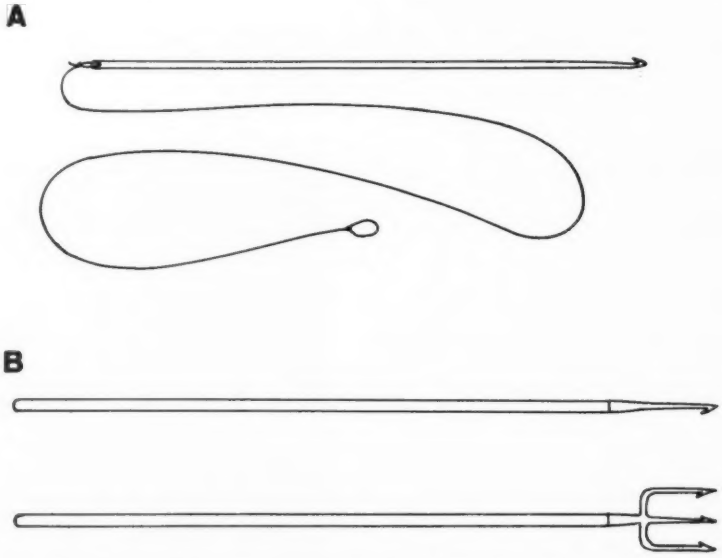


Figure 3.—Configuration of single and multiprong gigs used to spear fish in the ocean surf. A. Popular all metal gig with attached stringer of ⅛-inch nylon twine. B. Single and three-prong (trident) gigs with wood shafts.

Physical Conditions

Night stalking flounder in the ocean surf is possible only a few nights in the fall. On a good fishing night physical conditions must be suitable to allow wading waist deep in the surf and good visibility through the water. The most important physical conditions affecting fishing are described below.

Surf Zone

Successful stalking in the surf requires a knowledge of where to search for flounder. Flounder may be found anywhere in the surf zone in water only a few inches deep to water too deep for wading. However, certain portions of this fishable area are more productive than others. At low tide fish may be found outside the breaking waves beyond the low tide terrace, in the longshore trough (if the beach has one), and on the longshore bar (Fig. 2). The most productive fishing is done on the outer edge of the longshore bar or, when there is no longshore bar, just beyond the breaking waves in knee- to waist-deep water. The areas around rock jetties where flounder apparently concentrate for shelter and feeding are also productive. Stalking is generally less productive at high water because fishing is then necessarily confined to a smaller area (Fig. 2), i.e., the lower portion of the low-tide terrace and the adjacent part of the trough. Flounder are seldom found in areas where rip currents flow seaward (rip channels). Best fishing is done from about 1.5 hours before to 1.5 hours after low tide.

Wind

Wading waist-deep in the surf and at the same time keeping water out of one's waders is only possible when the waves are small, ideally less than 1 foot. Winds blowing from land to the ocean (offshore winds) tend to reduce the wave height and calm the surf.

Several days of moderate offshore winds are usually necessary to reduce the surf after a period of onshore (from ocean to land) winds. The fisherman contemplating a flounder gigging excursion should check the wind direction, speed, and duration as a clue to the condition of the surf or, if possible, make a trip to the beach to inspect wave conditions.

Water visibility usually increases as a result of the surf being calmed by offshore winds. Occasionally, however, water visibility may not be good even after a day or two of offshore winds because of the large amount of suspended material in the water (referred to as "thick" water). Also, strong winds from any direction may produce surface ripples and spray that hinder visibility.

Moon Phase

All other conditions being equal, stalking flounder is more successful on nights when there is little moonlight. New moon phase and cloudy nights will probably result in better fishing, but the fisherman should not forego fishing on moonlit nights if the other more important conditions described above are favorable. Flounder are apparently more light-adapted on moonlit nights and seem to swim about more. Those that are on the bottom will sometimes flee from the fisherman's light and motion. Floyd (1966) recommends that if gigging is done on moonlit nights the fisherman should move in the direction of the moon to prevent casting a shadow over the search area.

SPECIES CAUGHT

The predominant flounder gigged in the ocean surf in North Carolina below Cape Lookout is the southern flounder (*Paralichthys lethostigma*). The average size of individuals gigged is less than 3 pounds with limits of about 0.5 to 14 pounds. Smaller individuals (less than 2 pounds) are caught more frequently in the early part of the fall while larger ones are more abundant near the end of the fall season. Curiously, the catch of this species in the ocean surf is virtually all females. Of the 46 sexually mature flounder examined by the author in October and November of 1974, all were females. Males may be offshore in deeper water.

The summer flounder (*Paralichthys dentatus*) is gigged occasionally in the ocean surf during the late fall. The pounds of this species caught is probably less than one percent of the total catch of all flounders gigged in the surf. During the fall of 1974 the author caught two small summer flounders (1 pound each) in a total catch of about 300 pounds of flounders. Windowpane flounders (*Scophthalmus aquosus*) may also be seen in the ocean surf but, owing to their small size (about ⅓ pound maximum), are seldom gigged.

FISHING IMPLEMENTS

The equipment required for gigging flounder in the ocean surf zone is simple and relatively inexpensive. The essential gear consists of a gig and an artificial light.

The Gig

The gig or spear is a hand-held implement that is used for stabbing the fish. A simple, useful design (Fig. 3a) is a 3.5- to 5-foot metal rod of either steel or aluminum sharpened to a point on one end. The point is often fashioned with a barb and the opposite end of the rod has a hole drilled for attaching a fish stringer of ⅛-inch twine of nylon or other synthetic material. The rod should have a diameter large enough (about ⅜-inch) so that it can be grasped firmly and be durable enough to withstand the struggles of a large fish but yet small enough (in diameter) so that the fish is not unduly marred or the rod too heavy and unwieldy. Ready-made gigs of aluminum or steel can be purchased for several dollars at fishing supply stores. Home-made gigs can be made from nearly any available metal rod; especially suitable are concrete reinforcing rods which can be cut to the preferred length.

Also in common use are the commercially available single and multiprong gig points pre-welded to a socket which can be affixed to a wood shaft (Fig. 3b) of any desirable quality and length. These gigs are lighter weight than those made entirely of steel and can be used in deeper water but have the distinct disadvantage of not also serving as a fish stringer. The multiprong gigs will also unduly damage the fish.

The Light

The purpose of the light is to provide illumination of the bottom so that flounders may be seen by the stalker. The most efficient lighting of the bottom is by means of a waterproof underwater light powered by a conventional lead-acid battery. Gasoline lanterns are not recommended for use in the surf because saltwater splash will often crack the glass globe of the lantern when in use.

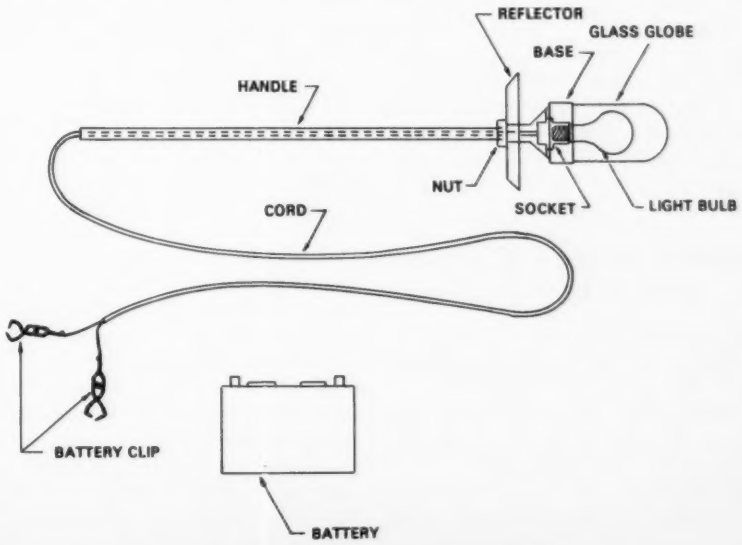


Figure 4.—Diagram of underwater light assembly.

A simple and relatively inexpensive underwater light (Fig. 4) can be constructed from materials available at many hardware or marine supply stores. A 4- or 5-foot section of ¾-inch diameter metal or polyvinyl chloride pipe is used as the shaft or handle. The pipe is threaded on the outside of one end for about 1-inch. A nut is tightened on the threaded end and a reflector, made of a heavy duty pie pan with a hole drilled in the center, is slipped on the pipe and the base tightened down to hold the reflector secure. The 14- or 16-gauge insulated electrical cord is pushed through the handle and the stripped conductor ends are attached to the socket terminals in the base of a vapor-proof interior marine light fixture. A 6- or 12-volt, 50- to 100-watt light bulb is then put in the socket and the heavy duty clear glass globe is screwed into the base. Silicone rubber caulking compound is applied to all joints to keep the assembly watertight. The opposite end of the handle can be wrapped with plastic insulation tape and also coated with the caulking compound. When it is necessary to repair the light the dried caulking compound can be removed with a knife. Finally, large battery pinch-clips are attached to each of the two wire terminals.

Underwater light assemblies resembling the one described above can be purchased in some fishing equipment stores for about a 50 percent higher cost than the above custom model can be made.

The power source for the underwater light is a conventional lead-acid battery; standard automotive, motorcycle, or tractor batteries are used. The voltage of the battery and light bulb must correspond. The battery should be selected for its compactness and weight since it is often carried by the fisherman during the fishing operation. The battery chosen should provide at least 2 hours of peak lighting for the wattage bulb used. The battery should be kept fully charged between fishing trips and seasons.

A side or back-pack of canvas, nylon, or other durable fabric is used to carry the battery during fishing. Military surplus knap-sacks or hiking back-packs are very suitable. The battery may first be placed in a heavy plastic bag then put into the carrying pack. It is desirable that the battery be kept as dry as possible and a top flap on the pack will ensure that saltwater splash is kept off the battery. The battery should be kept upright during fishing to prevent accidental acid spill.

Some fishermen prefer to carry their battery in either a #2 or #3 galvanized tub or a 20-gallon garbage can buoyed up with an automobile tire inner tube. While this portage may be easier than carrying a battery it does not allow the mobility of the back-pack method, and requires two persons to steady the float in the surf and to handle the gear when fish are caught and strung.

The fishing gear described herein is relatively simple and inexpensive to construct or purchase. The value of the catch to the sportsman from several successful nights of gigging can more than equal the modest cost of the equipment. It is not unusual for a person stalking alone in the surf to catch more than 50 pounds of flounder on a successful night.

LITERATURE CITED

Floyd, H. M. 1966. Commercial flounder gigging. U.S. Fish Wildl. Serv., Fish. Leafl. 586, 5 p.

Ginsburg, I. 1952. Flounders of the genus *Paralichthys* and related genera in American waters. U.S. Fish Wildl. Serv., Fish. Bull. 52:267-351.

Znamierowska-Prüffer, Maria. 1966. Thrusting implements for fishing in Poland and neighboring countries. (Transl. from Polish.) Sci. Publ. Foreign Coop. Center Central Inst. Sci. Tech. Econ. Inf., Warsaw, Poland, 536 p.

MFR Paper 1159. From Marine Fisheries Review, *Vol. 37, No. 9, September 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

U.S., Poland Sign Mid-Atlantic and North Pacific Fisheries Conservation Agreements

The United States and Poland concluded two fisheries conservation agreements in late May, the U.S. State Department reports. On 29 May representatives of both countries signed an agreement for improved conservation of such species as river herring found off the U.S. Atlantic Coast and increased protection for some shellfish and other continental shelf creatures, such as lobsters. On 30 May both Governments concluded a short-term fisheries agreement effective from 15 June to 31 December 1975 relating to fisheries of the North Pacific area from California to Alaska. This was the first such agreement between the two countries on Pacific Coast fisheries.

The new mid-Atlantic fisheries agreement—the latest in a series which began in 1969—places additional and much-needed restrictions upon Poland's fishing effort in waters of the western region of the middle Atlantic. These waters, heavily fished by foreign fleets, contain once-rich stocks of fish such as flounders, hake, and black sea bass which are particularly desired by U.S. consumers and which are of great importance to U.S. fishermen. The new restrictions include both additional reductions in the geographic area in which the Poles may fish and reductions in the amount of the Polish catch. For example, Poland agreed not to direct any fishing effort toward river herring and to avoid fishing at times and in places where concentrations of such fish occur.

As is the case with all such agreements concluded recently, the new arrangements provide for a number of practical measures that are to be taken to avoid catching or otherwise harming the fishery resources of the U.S. continental shelf, such as lobsters and some crabs. In order to help ensure that these and other provisions in the agreement are strictly adhered to, additional arrangements permit the use of observers upon Polish fishing vessels and allow for on-board inspection of catches and gear.

Practical measures to minimize the possibility of conflict between different types of fishing gear have been included within the agreement and, should such conflicts nevertheless occur, the new agreement continues the existing U.S.-Polish Fisheries Board, a mechanism aimed at providing for settlement of claims for damage from gear conflicts and consideration of other fisheries problems arising from the agreement.

In return for the many measures resulting in a reduction of the Polish fishery to protect resources of special interest to U.S. fishermen, the agreement continues to allow Polish vessels to conduct loading operations in the contiguous fisheries zone between 3 and 12 miles off the U.S. coast in three localities and to make limited port calls as before. A new provision permits Polish vessels a limited opportunity to exchange their crews in the Port of New York only.

The agreement entered into force 1 July 1975 and extends to 30 June 1976 and, if agreed at that time, may extend for another year. At the request of either government, it can be terminated upon 2 months notice at any time during the period of force of the agreement.

The U.S. delegation to the deliberations was headed by William L. Sullivan, Jr., Coordinator of Oceans and Fisheries in the Department of State, and included a number of representatives of the east coast fishing community. The Polish delegation was led by Deputy Minister of Foreign Trade and Maritime Affairs Romuald Pietraszek.

On 30 May, Poland, a relative newcomer to the North Pacific fisheries, agreed to maintain the level of her fishing effort in 1975 to not more than 15 vessels, of which not more than 11 vessels would fish at the same time. The 11 vessels will be dispersed in a manner designed to avoid a concentration of vessels in one locality.

Poland agreed to refrain from fishing for salmon and halibut and will not conduct specialized fisheries for other species of special importance to the United States. These species include rockfish, blackcod, flounders, soles, anchovy, Pacific mackerel, and shrimp. At the same time, Polish vessels will, during the period of the Agreement, begin to switch from bottom trawling to pelagic trawling, thereby minimizing the chances of catching bottom species which U.S. fishermen primarily seek. In addition, Poland has agreed to abide by the conservation provisions of the agreements concluded between the United States and other countries fishing in the North Pacific. Furthermore, Poland agreed to refrain from fishing in a new closed area off northern California where U.S. fishermen fish with fixed gear so as to prevent damaging the U.S. gear.

Both Governments agreed to expand their research on species of interest to both sides and to exchange biostatistical data on a timely basis. Both Governments also agreed to initiate a program whereby fisheries experts from one side could board vessels of the other side to observe their operations and collect data. In this regard, the Polish side also agreed to permit duly authorized U.S. Federal and State officials to board and conduct inspections of their vessels.

The new Agreement also spells out measures which the Polish fishermen will take to avoid taking U.S. continental shelf resources, such as king and tanner crabs. In return for the cooperation extended by the Polish side in agreeing to observe existing conservation arrangements in the North Pacific, the United States will permit Polish vessels to conduct loading operations in two localities in the U.S. contiguous fishery zone (3-12 miles).

Marine Recreation Survey Details Fishing Activity

Almost 11 million people in 13 northeastern States and the District of Columbia participated in saltwater recreational fishing activities last year, according to a survey early this year by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). The 10,856,000 people represented 4,986,000 households, or a little more than two people

per household surveyed. The combination telephone and mail survey was conducted by a private company under contract to NOAA's National Marine Fisheries Service and included the District of Columbia, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia.

New York State was most active in marine recreational finfishing and shellfishing with almost 3 million people representing over 1 million households. Vermont had the lowest activity with about 39,000 people in 18,000 households participating. The survey also determined that swimming was the most popular of all marine recreational activities, followed by finfishing, beachcombing, pleasure boating, sailing, and shellfishing.

These survey results are the first of two parts. Those people who responded to the telephone survey by indicating participation in saltwater recreational activities were sent questionnaires to learn how many and what kinds of fish and shellfish were caught and how much time and money was spent for saltwater recreational activities. The data received from the questionnaires has been analyzed and the results of the complete survey will be available soon.

More detailed information on the telephone survey is available in an NMFS report, "Participation in Marine Recreational Fishing, Northeastern United States, 1973-74," CFS No. 6236, free of charge, from the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Washington, DC 20235.

NMFS Scientists Study Radio-Tagged Fur Seals

Scientists at the National Marine Fisheries Service's Northwest Fisheries Center, Seattle, Washington, have equipped fur seals with sound to gain more information on their feeding, movements, and behavior. Harnesses with radio transmitters were attached to 50 young male fur seals when they returned to St. George Island last July. St. George and St. Paul are two of the Pribilof Islands in the Bering Sea that are used for breeding grounds by approximately 80 percent (1.3 million) of the world's northern fur seals.

Fur seals are harvested each year on St. Paul Island by the Department of Commerce's National Oceanic and Atmospheric Administration under the provisions of the Interim Convention on the Conservation of North Pacific Fur Seals. Commercial harvesting on St. George Island was stopped in 1973 to permit scientists to study a protected population of northern fur seals.

Practically nothing is known about the normal cyclic activity of the young males because they have traditionally made up most of the annual harvest, which normally took place in June or early July. Lack of this knowledge reduces the accuracy of population estimates for young males. A count of these animals on land cannot give the total population because there are always animals feeding at sea and many arrive at the island as late as October. The census is further complicated because of differences in behavior due to age and because the ratio of the number of animals on and offshore probably changes because of weather and human disturbances.

Use of telemetry equipment becomes even more essential for studying the behavior of young males because they do not confine themselves to a particular land area as do adult males and females with pups. The young males move readily from one land area to another making it very difficult to keep an accurate record of their movements.

The transmitters have a range of about one-half mile and monitoring extended a little over three months. Each of the transmitters had a different frequency and pulse repetition permiting the scientists to identify the individual seals.

Seals equipped with the radios were between two and five years old and weighed 50 to 115 pounds. Full grown males weigh 400 to 600 pounds. The scientists planned to recover the harnesses from the seals; however, a saltwater corrosion mechanism on the harness will release it if not recovered, preventing any adverse long-term effect on the animal's movements.

Minced Fish May Soon Be Available to Homemakers

Fish as easy and convenient to use as hamburger may soon be available to the homemaker, according to the Department of Commerce's National Oceanic and Atmospheric Administration. Experiments conducted by NOAA's National Marine Fisheries Service's Utilization Research Center at Gloucester, Mass., show that minced fish can be produced that has the same texture as hamburger. It has the same nutritional value as beef, is lower in fat content, and is cheaper to produce since it can be made from a variety of fish species that are not being used to the fullest extent. Joe Mendelsohn, Project Director at the NMFS Center, said that minced fish in 1-pound frozen blocks is a highly acceptable market form and has commercial potential for both retail and institutional trades.

In the early 1970's a new technology was begun with the introduction of a meat-bone separator machine to the fishing industry. The machine removes the bones, skin, and scales from fish that have been headed and eviscerated and produces fish flesh resembling hamburger. It produces more edible flesh from a fish than can be obtained by hand or machine filleting, thereby making it cheaper to produce. As a result of this technology and a shortage of whole fillets for conventional frozen blocks, fish processors began using minced fish to produce 13.5- to 18.5-pound blocks which they use to produce fish sticks and portions.

"Because of the previous success experienced in processing large blocks into sticks and portions, the market potential for a small 1-pound frozen fish block suitable for home use was investigated," said Mendelsohn. "A package would contain enough fish for one meal which the housewife could use in tested recipes provided on the package or in recipes she might develop herself."

A variety of products including fish cakes, chowders, salads, fish in spaghetti or marinara sauce, fish and rice, fish stew, and fish and beef were prepared at the Utilization Research Center, tested by families, and found to be highly acceptable. Those testing

the fish commented on the convenience of the blocks and the absence of a "fishy" smell.

"The 1-pound frozen block of minced fish is adaptable for use in most fish recipes and as an extender for hamburger," said Mendelsohn. "It is convenient, requires no preparation for use directly into many recipes, and is very economical when compared to other fish products," he concluded.

U.S. FISHERY PRODUCT IMPORTS REPORTED FOR 1974

In 1974, the United States imported 2.2 billion pounds of edible fishery products valued at slightly under $1.5 billion. Japan and Canada accounted for almost 50 percent of imports by quantity, and over 35 percent by dollar value (Tables 1 and 2).

U.S. imports from North America and Europe declined from 1973 to 1974 in both quantity and value. Imports from South America and Africa declined in quantity, but increased in value. Imports from Asia and Australia/Oceania increased in both quantity and value (Table 3).

In 1974, the total quantity of fishery imports was 8.5 percent smaller than in 1973; the total value of imports, however, increased by 5.6 percent during the same period.

The United States in 1974 exported 178 million pounds of edible fishery products valued at $195 million. This represented a decrease of over 25 percent in quantity and almost 20 percent in dollar value from the 1973 totals.

Source: *Fisheries of the United States, 1974.*

Table 1.—U.S. fishery imports, by quantity, 1974 (percentages in declining order).

Country	Percent	Country	Percent
Japan	30.5	Malagasy Rep.	0.8
Canada	19.4	Australia	0.7
Mexico	4.7	Mauritius	0.7
Iceland	4.3	Portugal	0.7
Norway	3.1	Ivory Coast	0.6
Denmark	2.9	Canary Isl.	0.5
South Africa	2.6	Venezuela	0.5
Spain	2.0	Poland	0.4
Taiwan	2.0	Nicaragua	0.4
Rep. of Korea	1.8	Guyana	0.3
India	1.6	Indonesia	0.3
Brazil	1.2	Colombia	0.3
Ecuador	1.1	El Salvador	0.3
Philippines	1.1	Netherlands	0.3
Panama	1.0	New Zealand	0.3
U.K.	1.0	Honduras	0.2
Br. Pac. Isl.	0.9	Others	11.5
		Total	100.0

Table 2.—U.S. fishery imports, by value, 1974 (percentages in declining order).

Country	Percent	Country	Percent
Japan	20.0	New Zealand	1.0
Canada	15.8	Nicaragua	1.0
Mexico	11.5	Colombia	0.9
Iceland	4.8	Guyana	0.8
Australia	3.7	Indonesia	0.7
Norway	3.4	El Salvador	0.7
South Africa	2.9	Philippines	0.6
Denmark	2.8	Portugal	0.6
India	2.6	Br. Pac. Isl.	0.6
Brazil	2.4	Honduras	0.6
Panama	1.9	Mauritius	0.5
Taiwan	1.7	Netherlands	0.5
Spain	1.4	Poland	0.4
Ecuador	1.2	Malagasy Rep.	0.4
Rep. of Korea	1.2	Ivory Coast	0.4
Venezuela	1.2	Canary Isl.	0.4
U.K.	1.1	Others	11.3
		Total	100.0

Table 3.—Imports of edible fishery products, by continent and country of origin, 1973 and 1974.

Continent and country	1973		1974	
	1,000 lb	$1,000	1,000 lb	$1,000
North America				
Canada	525,700	301,623	428,242	233,152
Mexico	106,540	127,985	104,445	169,805
Panama	26,163	20,623	23,335	27,436
Nicaragua	7,528	10,697	9,016	15,030
El Salvador	5,918	8,011	6,109	9,686
Honduras	3,966	5,787	4,425	8,945
Other	60,495	39,114	47,681	35,706
Total	736,310	513,840	623,253	499,760
South America				
Brazil	24,400	29,635	25,976	35,009
Ecuador	24,451	16,231	25,250	18,015
Venezuela	12,110	14,598	10,277	17,575
Colombia	7,241	10,051	6,979	12,997
Guyana	10,458	15,709	7,376	12,122
Other	81,219	30,605	66,264	26,083
Total	159,879	116,829	142,122	121,801
Europe				
Iceland	115,408	72,569	94,902	70,222
Norway	106,565	60,736	68,302	50,059
Denmark	83,838	50,815	63,532	41,611
Spain	19,225	13,669	43,385	20,415
United Kingdom	35,078	24,169	22,495	16,537
Portugal	19,374	11,702	15,010	9,216
Netherlands	11,145	10,657	6,037	7,066
Poland	10,439	5,416	9,539	5,841
Other	46,535	15,458	20,752	5,666
Total	447,607	265,191	343,954	226,633
Asia				
Japan	619,488	237,074	675,525	295,864
India	25,316	22,746	36,341	38,271
China, Republic of (Taiwan)	44,999	24,176	42,432	24,589
Korea, Republic of	24,637	11,113	39,226	17,996
Indonesia	9,189	6,078	7,060	9,912
Philippines	24,314	8,341	24,611	9,339
Other	58,585	41,188	49,469	55,994
Total	806,528	350,716	874,664	451,965
Australia and Oceania				
Australia	19,603	43,980	15,563	54,297
New Zealand	5,311	13,268	5,729	15,431
British Pacific Islands	20,648	9,511	19,402	9,111
Other	31,616	10,815	45,418	16,495
Total	77,178	77,574	86,112	95,334
Africa				
South Africa, Republic of	66,016	35,493	56,756	43,447
Mauritius	13,575	6,853	15,027	7,400
Malagasy Republic	15,824	5,185	16,617	5,507
Canary Islands	8,146	3,715	10,299	5,442
Ivory Coast	12,454	3,620	12,281	5,283
Other	72,676	19,468	30,912	15,346
Total	188,691	74,334	141,892	82,425
Grand total	2,416,193	1,398,484	2,211,997	1,477,918

Source: Department of Commerce, Bureau of the Census.

Outstanding NMFS Papers Are Honored

Special Achievement Awards of $300 each have been approved for National Marine Fisheries Service authors of the two Outstanding Publications of Calendar Year 1973 in the *Fishery Bulletin* and *Marine Fisheries Review*. The selections, made by the NMFS Publications Policy Board, must constitute an outstanding original scientific work which contributes to accomplishing the NMFS mission.

Roland A. Finch received the Special Achievement Award for his paper "Effects of Regulatory Guidelines on the Intake of Mercury from Fish—the MECCA Project." It was published in the July 1973 issue of *Fishery Bulletin* (Volume 71, Number 3). MECCA is an acronym for Model for the Estimation of the Consumption of Contaminants from Aquatic Foods. Finch is with the Fishery Products Research and Inspection Division, NMFS, NOAA, Washington, D.C.

The second Special Achievement Award went to Donald R. Whitaker for his paper "Why the Cod Shortage? What are the Alternatives?" in the November 1973 issue of *Marine Fisheries Review* (Volume 35, Number 11). He is with the Fishery Products Research and Inspection Division, NMFS, NOAA, Washington, D.C.

Receiving Honorable Mention for *Fishery Bulletin* papers were William W. Fox, Jr. for "A General Life History Exploited Population Simulator with Pandalid Shrimp as an Example" (Volume 71, Number 4) and Wesley J. Ebel, Donn L. Park, and Richard C. Johnson for "Effects of Transportation on Survival and Homing of Snake River Chinook Salmon and Steelhead Trout" (Volume 71, Number 2). William N. Lindall, Jr. won Honorable Mention for his paper "Alterations of Estuaries of South Florida: A Threat to its Fish Resources" in the October 1973 issue of *Marine Fisheries Review* (Volume 35, Number 10).

U.S. Fish Catch Up, Prices Down in 1974

Commercial fishery landings at U.S. ports by U.S. fishermen increased 4 percent in 1974 over 1973, according to preliminary figures released by the National Oceanic and Atmospheric Administration (NOAA). The Commerce Department agency reported, however, that the 4.9 billion pounds, worth $898.5 million, was about 1 percent less in value than the 1973 landings.

Larger landings of fish for industrial use was the major reason for the increase in volume while a sharp decrease in the price fishermen received for higher valued shellfish and a decline in industrial fish prices contributed to the slight decrease in total value. The data collected by NOAA's National Marine Fisheries Service indicates the per capita consumption of fishery products dropped from the record high of 12.7 pounds in 1973 to 12 pounds in 1974. The 1974 per capita consumption remained slightly higher than the past 5-year average of 11.9 pounds, however.

Total imports of fishery products reached a record high of $1.69 billion, up 7 percent over the previous record high of $1.58 billion set in 1973. The value of fishery products processed in the United States from both domestic and imported raw materials was a record $2.8 billion, up 2 percent from 1973. Edible fresh and frozen products accounted for 44 percent, edible canned products 39 percent, cured products 3 percent, and industrial products 14 percent of the total processed.

The nation's most valuable fishery was the domestic shrimp industry which accounted for 20 percent of the total off-vessel value of U.S. landings. The value of shrimp landings, $177.9 million, was 19 percent less than the 1973 record value, however.

Tuna landings of 386.2 million pounds at U.S. ports were 44.1 million pounds (13 percent) more than in 1973. Landings of all species except bluefin tuna increased sharply. An additional 165 million pounds of tuna were landed by U.S. fishermen in Puerto Rico.

The 1974 top 10 ports with commercial landings in millions of pounds were:

San Pedro, Calif.	438.9
Cameron, La.	405.2
Empire, La.	243.8
Pascagoula-Moss Point, La.	241.8
Dulac-Chauvin, La.	206.1
Morgan City, La.	141.5
Gloucester, Mass.	121.0
Kodiak, Alaska	112.9
Beaufort-Morehead City, N.C.	78.8
San Diego, Calif.	78.7

The top 10 ports in terms of value of landings in millions of dollars were:

San Pedro, Calif.	78.8 (record)
Kodiak, Alaska	29.1
Brownsville, Tex.	23.2
San Diego, Calif.	22.1
New Bedford, Mass.	21.2
Aransas Pass, Tex.	19.8
Cameron, La.	18.7
Dulac-Chauvin, La.	16.8
Astoria, Ore.	13.7
Bayou La Batre, Al.	13.1

Details of these and other preliminary data dealing with U.S. fisheries are included in *Fisheries of the United States, 1974*. Single copies may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, for $1.70.

NMFS Slates Marine Recreational Fishing Survey in Southeast

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) has initiated a survey to determine the number of saltwater recreational fishermen in the Southeast United States. The survey is being done by Chilton Research Services under contract to NOAA's National Marine Fisheries Service and is being conducted in the eight coastal States of the Southeast and Gulf of Mexico, beginning with North Carolina and ending with Texas.

In addition to an estimate of the number of recreational fishermen in the area, the survey will provide an estimate of the number and pounds of fish and shellfish caught in each State, the use made of that fish and shellfish, the number of days spent fishing, and expenditures by saltwater recreational fishermen. Three techniques will be used in the survey: (1) a telephone screening to establish a sample of saltwater recreational fishermen; (2) a questionnaire sent to a sample of the fishermen identified in the screening survey asking detailed questions on numbers and pounds of fish caught by species, amount of time spent fishing, and other information; and (3) a telephone followup to individuals who do not return the questionnaire asking the same questions that are asked on the mail questionnaire.

Results of the telephone screening part of the survey are expected to be

published soon and the final results of the complete survey in the spring of 1976. Information gained from the survey will be used in cooperative State/Federal efforts to develop fishery management programs. Details of the survey can be obtained by contacting Statistics and Market News Division, National Marine Fisheries Service, NOAA, Washington, DC 20235.

Current Fishing Industry Market Prices Available

Fishery Market News Reports are now available by subscription according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. The reports publish pertinent information on current wholesale market prices, exvessel prices, landings, imports, and movements of fishery products both in the United States and abroad. The data are gathered daily by the Commerce Department agency, through telephone and personal contact with key fishing ports and markets for fishery products.

In addition to marketing information, *Fishery Market News Reports* contain news items of interest to people in the fishing industry. The reports are published in five cities: Boston; New York; New Orleans; Terminal Island, Calif.; and Seattle, on Monday, Wednesday, and Friday. In addition to the daily information, a weekly summary for each of the cities is published on Fridays.

The New York report specializes in wholesale prices for fresh and frozen fishery products traded in New York merchandising centers. The Boston report carries the Boston fish auction prices, the New Bedford auction prices, exvessel prices, landings in selected New England ports, Chicago market receipts, and frozen wholesale prices for the New England and Chicago areas. The New Orleans report carries Gulf shrimp landings and exvessel prices and the Terminal Island report specializes in data pertaining to the tuna industry. The Seattle report contains information on the halibut, salmon, groundfish, king crab, and shrimp fisheries in the northwestern United States as well as Alaska. The Seattle report also publishes data on British Columbia fisheries.

Annual subscription rates for three reports per week plus the weekly summary is $35.00 per report (i.e., Boston, New York, New Orleans, Terminal Island, or Seattle). The weekly summaries are available for $15.00 per year per report.

Subscriptions may be started by making checks or money orders payable to the Department of Commerce, NOAA, and mailing them to the U.S. Department of Commerce, NOAA, National Marine Fisheries Services, F2x1, Room 404, Page Building 2, Washington, DC 20235.

Foreign Fishery Developments

Aid Eyed for Italy's Ailing Marine Fishery

During the past 2 years the Italian high-seas fisheries have been facing increasing difficulties, particularly because of the trend toward the extension of fisheries jurisdictions off West Africa, the traditional grounds for Italian fishing vessels, according to Mario Iandoli, President, Italian National Federation of Fishery Enterprises (FEDERPESCA), writing in *La Pêche Maritime*. This development has forced the Italian fleet to travel to more distant and less abundant grounds off North America and Southern Africa. The Italian fisheries are becoming noncompetitive because of declining catch rates and the lengthening of the distances between home ports and overseas fishing grounds. The time required for each trip has tripled (from 40-50 days to 150-160 days) and costs have increased sharply, reducing profits and causing losses.

Two years ago, 95 Italian vessels fished the Atlantic. The development of such a large fleet had been made possible by assistance from the Government, which gave a 130-150 million lire (US$200,000-220,000) subsidy for each high-seas freezer trawler and facilitated the payments on up to 50 percent of the construction costs.

Today, the total number of Italian high-seas fishing vessels has decreased to 65. The vessels having small gross tonnage (particularly those having less than 600 GRT) can no longer operate profitably. Their costs are almost equal to those of larger vessels while their catches are much less. Many such vessels have been sold or were decommissioned.

Several proposals have been made to assist the ailing fishing industry. Joint operations with West African coastal countries have been suggested. Such ventures would especially benefit Italian shipyards and fishing gear factories, and would also permit Italian fleets to continue operations along the West African coast and an Italian entry into African fishery markets. This option would require considerable investments. The Italian government will have to study the possibility of financial and technical assistance to the industry as is being done by the Governments of France, Spain, Portugal, Greece, Norway, and Japan.

A proposal to build up an Italian fleet of 100 large fishing vessels with a total gross tonnage of 160,000-200,000 tons has been made. The emphasis on larger vessels with an average of 1,600-2,000 GRT was made because vessels of lesser tonnage are no longer profitable. The annual catch could then double from 75,000 to 150,000 metric tons and would be worth over 30 billion lire ($45 million). This would help to eliminate deficit imports of fish and other fishery products.

The restructuring of the Italian fishing fleet, however, requires a plan of coordination under which the Government provides at least a part of the investments especially in the form of easy credit. Large and effective grants must be made to compensate partially for the disadvantages resulting from longer trips to grounds very far from Italy.

Urgent action is necessary. Delivery contracts for fish cannot be deferred—the processing industry must continue to produce, or it runs the risk of depriving the market of an important source of food, and causing strikes. Positive action would help Italian shipyards, repair yards, and related industries.

Canada Implements Fishery Subsidies

On 1 January 1975, Canada implemented a C$20 million short-term assistance plan for Canadian fishermen, trawler operators, and processors to help rehabilitate the Canadian groundfish industry.[1] The plan was designed to keep the groundfish fleets in operation during the winter months by partially offsetting rapidly rising costs for fishermen, and by assisting processors in reopening seasonal plants hard hit in 1974 by late ice conditions. This plan terminated on April 30.

On 1 May, a new C$50 million subsidy plan, designed to provide both, long-term financial assistance and economic planning for the future, went into effect. Canadian Fisheries Minister Romeo Le Blanc stated that new initiatives with respect to resource management, harvesting, processing, and marketing were necessary to achieve the long-term goal of reestablishing a healthy fishing industry.

The new C$50 million assistance plan involves two programs. First, the groundfish program will provide support of up to C$28 million for inshore and offshore fishermen owning vessels and producing first-quality fish. This program also provides up to C$12 million in assistance to those processing plants which agree to maintain 1 July 1974 prices for fishermen. Selective fisheries on both the Atlantic and Pacific coast will receive benefits; however, most of the funds will be used to assist the ailing Atlantic provinces.

Second, a sum of C$10 million will be provided "to help solve marketing problems encountered by other segments of the industry throughout Canada, and will involve deficiency payments, inventory financing, and the processing of fish for use in international food aid programs."

[1]In the fall of 1974 the Canadian Government spent C$15 million in an initial attempt to shore up the fishing industry.

MOROCCO LOBSTER EXPORTS LISTED

Three species of lobster are commonly caught in Moroccan waters: (1) Norway lobster, *Nephrops norvegicus*; (2) European lobster, *Homarus vulgaris*; (3) European spiny lobster, *Palinurus mauritanicus*, called "langouste" in Morocco.

In 1973, total Moroccan lobster exports amounted to about 150 metric tons valued at roughly US$1.3 million. The U.S. Regional Fisheries Attache reports that lobster is difficult to find in Casablanca's hotels and restaurants because of limited landings and heavy exports. Most lobster exports go to France, Spain, Italy, and Portugal. Tables 1 and 2 provide a detailed breakdown of Morocco's 1973 lobster exports.

Table 1.—Moroccan exports of lobster[1], by quantity and value, 1973.

Commodity	Quantity (kg)	Value	
		Dirhams[2]	US$
Lobster tails	451	15,120	3,780
Lobster, live	47,827	1,297,150	324,288
Lobster, whole	2,687	59,690	14,923
Lobster, whole, nes	305	9,030	2,258
Langouste, whole	103,681	3,882,260	970,565
Total	148,951	5,263,250	1,315,814

[1]Source: MAROC. Ministere des Finances. Office des Changes. *Statistiques du Commerce Exterieur*, Rabat, 1974.
[2]US$1.00 = 4 Dirhams.

Table 2.—Average price of Morocco's lobster exports[1], 1973.

Commodity	Dirhams/kg	US$/lb
Lobster tails	33.52	3.80
Lobster, live	31.01	3.52
Lobster, whole	22.21	2.52
Lobster, whole, nes	29.60	3.36
Langouste, whole	37.44	4.25

[1]Source: MAROC. Ministere des Finances. Office des Changes. *Statistiques du Commerce Exterieur*, Rabat, 1974.

Philippines Fishery Development Assistance Reported

The Annual Report on Development Assistance to the Philippines for 1974 has recently been published by the Manila Office of the United Nations Development Program (UNDP). The total amount committed for fisheries projects (for which statistics are available) was over US$1,606,985. Financial data on a number of projects is not available, however, and some of the funds noted below were actually spent prior to 1974 on projects operational over an extended period of time. (See the table below.)

Project/Activity	Source of assistance	Amount (US$)	Period of commitment	Nature of assistance
Fishermen's Training Center	UNDP	1,019,263	1972-76	Advisory services, fellowships, equipment (in Cavite)
Inland Fishery Biology	UNDP	171,901	1969-74	Advisory services for fish pond production in Luzon and Viscaya
Trap Net Fishing	Govt. of Japan	7,582	1974-75	3 experts to demonstrate above in Panay
Fishery Statistics	Govt. of Japan	17,060	1974-75	One statistician and equipment
Shrimp Culture	Govt. of Japan	345,935	1974	6 experts and equipment
Fisheries Development	Govt. of Japan	10,244	1974	Nets and generators to help trap-net fishing
Fisheries Development	Govt. of Norway	35,000	1974	Services of 5 experts
Total	—	1,606,985	—	—

Source: *Annual Report on Development Assistance to the Philippines* by Donald R. Bergstrom, Resident Representative, UNDP, Manila, April 1975.

Japan Searches for New Fishing Grounds

The Maritime Fishery Resource Development Center of Japan has dispatched a 3,300-gross-ton research vessel to survey deep-sea waters south of New Zealand, the *Japan Times* reports. The *Shinkai Maru* left Tokyo on 9 April for a 5-month voyage during which she will make 6 hauls daily in an area covering 400,000 square kilometers. When the survey is finished, the *Shinkai Maru* will be sent to assess fishery resources of the Southeast Pacific and the North Atlantic.

At present, Japanese vessels catch about 10 million metric tons of fishery products annually; the Maritime Fishery Resource Development Center hopes that its research vessels will discover new deep-sea fishery resources that will help maintain Japan's fishery landings at current levels.

The NMFS Office of International Fisheries reports that Japanese fishermen face the loss of traditional fishing grounds as the countries, off whose coasts they now fish, increase their control over marine resources by extending fishery jurisdictions.

The Soviet Union, whose large fishery fleets are faced with the same problem, is also devoting more and more of its fisheries research to deep-water investigations.

Problems Plague Japan's Tuna Fishing Industry

Severe management difficulties confronting Japanese distant-water tuna vessel owners are resulting in mounting cases of bankruptcy, vessel tie-ups, and curtailment of business. Many vessel owners are also reported to be on the verge of bankruptcy. Estimates based on studies made by the Fisheries Agency, lending institutions, and industry indicate that, as of the end of April 1975, there were 36 cases of bankruptcy involving 56 vessels, 23 cases involving 24 vessel tie-ups, and 40 cases of business curtailment affecting 53 vessels, totaling 99 cases and 133 vessels. In addition, about 101 enterprises are threatened with bankruptcy. The removal from the fishery of over 10 percent of the high-seas tuna fleet (of about 1,200 vessels) is indicative of the grave crisis confronting the Japanese fishing industry.

Although tuna imports from South Korea have contributed partly to the plight of the Japanese tuna vessel owners, the Fisheries Agency's view is that the problem was the outcome of weakening management structure compounded by the energy crisis that struck the industry. The Agency, which in 1974 had provided 9 billion yen (US$30 million) to help the tuna industry recover from the energy crisis, has declared that steps will be taken to aid the industry, but no specific measure had been developed by mid-year.

Japanese frozen tuna exports during January-March 1975 totaled 13,775 tons valued at 1,636 million yen (US$5.5 million). This is a sharp decline of 66 percent in quantity and 80 percent in value from the comparable 1974 exports of 41,594 tons worth 8,272 million yen (US$27.6 million). Exports to the U.S. mainland fell drastically, amounting to only 4.3 percent in quantity of the previous year's levels, and exports to Puerto Rico dropped to 43 percent.

By species, skipjack and albacore exports dipped particularly heavily. Skipjack, which recorded 10,376 tons during January-March this year, were down 20,000 tons or 66 percent from 1974, and albacore, at 463 tons, were down 6,300 tons or 93 percent. Exports to the U.S. mainland declined to 3.8 percent of last year's levels for skipjack, 2.7 percent for albacore, and 50 percent for yellowfin. Shipments to Puerto Rico fell to 25 percent for skipjack and albacore, and 50 percent for yellowfin. In view of the present U.S. tuna market conditions, Japanese trading firms foresaw no short-term recovery of sales to the United States and felt that tuna exports would suffer devastating setbacks this year.

Source: *Suisan Keizai Shimbun.*

Salmon Subsidy Paid Greenland Fishermen

Greenland was allocated a 1,191-metric-ton catch of migratory salmon by the International Commission for the Northwest Atlantic Fisheries for the 1974 fishing season. This quota was surpassed (by 8 tons) 3 months before the season officially ended on 30 November, according to the U.S. Embassy, Copenhagen, Denmark. As a result, many small craft fishermen located in remote and isolated areas of northern Greenland had not yet caught their share of the Total Allowable Catch (TAC), when the Danish government ordered all salmon fishing operations to cease.

As these fishermen depend heavily upon salmon revenues for their livelihood, the Fisheries Ministry for Greenland and the Greenland Provincial Council agreed that a one-time cash compensation of $100,000 would be awarded to the salmon fishermen. Each agency would share half the cost, and while the compensation was awarded on a one-time basis, it was indicated that the award would not prejudice any similar future compensations should they become necessary.

Shrimp Operators off Guyana Face Financial Crisis

Twelve Japanese fishery companies, with a total of 123 trawlers, have been engaged in shrimp fishing off Guyana (northeastern South America) the NMFS Office of International Fisheries reports. Until a few years ago, these trawlers had each landed an average of 45-50 metric tons of shrimp annually realizing profits of 10-12 percent. However, skyrocketing fuel, labor, and fishing gear costs, declining catches (landings have decreased 20-30 percent since mid-1974), and static market prices have caused substantial financial losses to the Japanese companies.

Hit particularly hard are those companies which entered the Guyana shrimp fishery in 1973. The inexperience in managing fleet operations and the burden of payments on loans for newly-built boats have accentuated their financial problems. One of these firms tied up its vessels early this year; two others were expected to suspend operations later. The remaining two companies (Nihon Enyo Gyogyo and Guyana Suisan), both based in Georgetown, Guyana, planned to transfer their operations to Barranquilla, Colombia, where diesel fuel could be purchased at one-third the Guyana cost. The above 5 companies own a total of 32 fishing vessels and it is believed that they will all either go out of business, or switch to different fishing grounds and/or bases.

To overcome the problem of declining catch, several firms planned to shift their operations from coastal to deep-water fishing, following the example of U.S. shrimp fishermen. The Japanese hope to fish at depths of 150-200 meters and may even try for 300 meters (Japanese trawlers are presently fishing at depths of 50-80 meters). U.S. deep-water shrimp fishing methods and gear modifications will be studied.

An estimated 47 Republic of Korea vessels are also fishing for shrimp off the Guianas. This total may reach 70 to 90 when vessels now being built are added to the fleet. The construction of about 30 of these new vessels reportedly is being financed by Japanese trading firms.

Sources: *Suisan Tsushin, Suisan Keizai Shimbun.*

Japanese Whale Fishery Extension Explored

A representative of a Japanese whaling company explored the possibility of harvesting gray whales off the coast of Baja California, Mexico this spring according to a report in the *San Diego Union*. The proposal envisioned Japanese whaling and processing vessels operating from shore stations in Mexico and harvesting whales commercially.

According to the International Fisheries Analysis Division, National Marine Fisheries Service, NOAA, the harvesting of California gray whales is banned by the International Whaling Commission, to which Japan belongs. The Japanese Embassy in Washington, D.C. has assured the U.S. Department of State that Japan intends to respect the ban.

Whaling is an important industry in Japan the International Fisheries Analysis Division reports. According to industry sources, whaling employs 50,000 persons and provides about 10 percent of Japan's total protein consumption. Declining whale populations are causing difficult adjustments to the industry. Already six large Japanese whaling companies have been forced to merge their operations[1]. The Mexican initiative is part of a concerted Japanese effort to seek out new whaling grounds.

Whales have been under the protection of the Mexican Government since 1964 and sanctuary status has been conferred on Scammon's Lagoon in Baja California where the gray whales give birth to their young after the annual Alaskan migration. According to the Japanese representative, Motosuki Yuri, some Mexican fishermen would like to see whaling operations as the whales "interfere with fishing operations." However, Porfirio A. Romay of the Mexican Fisheries Commission in San Diego doubts Mexican approval. According to Romay, "the Mexican Government wants to preserve the whales as a precious natural resource." Additionally, the whales represent an important attraction for Baja California's developing tourist economy.

Several United States conservation organizations learned of the proposal and began to organize a protest. Al Prentis, Charter President of the American Cetácean Society, estimates that about 1,000 gray whales could be harvested without endangering the species. However, he is opposed to any whaling because of the difficulty in regulating whaling operations.

[1]See "Japanese Firms Merge, Halve Fleets," *Marine Fisheries Review*, August 1975, 37(8):38.

Publications

Recent NMFS Scientific Publications

NOAA Technical Report NMFS SSRF-687. Reintjes, John W., and Peggy M. Keney. **"Annotated Bibliography on the biology of the menhadens, genus *Brevoortia*, 1963-1973."** April 1975, 92 p. Individual copies are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.

ABSTRACT

A bibliography that consists of 444 references on the classification, distribution, abundance, life history, and ecology of American menhadens, genus *Brevoortia*. Included are references to menhaden published from 1963 through 1973 with those references published prior to 1963 that were omitted from menhaden bibliographies by Reintjes et al. (1960) and Reintjes (1964a). Brief annotations and a subject index are included.

NOAA Technical Report NMFS SSRF-688. Blahm, Theodore H., Robert J. McConnell, and George R. Snyder. **"Effect of gas supersaturated Columbia River water on the survival of juvenile chinook and coho salmon."** April 1975, iii + 22 p. Individual copies are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.

ABSTRACT

The deleterious effect of high concentrations of dissolved gas on valuable stocks of Columbia River salmon and trout has led pollution control agencies in the Pacific Northwest to consider establishing standards for the amount of dissolved gas in the water. Research has been done with salmonids to define the criteria upon which such standards should be based, but the majority of these studies were carried out in shallow tanks (less than 1 m deep) where supersaturated concentrations of gas had been artificially induced. This report discusses tests that were performed at a field laboratory on the Columbia River. Juvenile chinook, *Oncorhynchus tshawytscha*, and coho, *O. kisutch*, salmon were tested in deep and shallow tanks with river water reflecting the prevailing (and fluctuating) concentrations of dissolved gases. Results indicated that the water depth in a deep (3 m) test tank enhanced the survival of test fish compared to shallow tanks (< 1 m). These tests support the hypothesis that test conditions in tanks 1 m deep are not representative of all river conditions that directly relate to mortality of juvenile salmon and trout in the Columbia River.

Data Report 101. Wahle, Roy J., William D. Parente, Paula J. Jurich, and Robert R. Vreeland. **"Releases of anadromous salmon and trout from Pacific Coast rearing facilities, 1960 to 1973."** April 1975. 443 p. on 7 microfiche. For sale by U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22131.

ABSTRACT

Releases of anadromous salmon, *Oncorhynchus* spp., and trout, *Salmo* spp., from all rearing facilities in Alaska, British Columbia, Washington, Idaho, Oregon, and California are listed for the years 1960 through 1973. A total of 113 hatcheries, 42 rearing ponds, and 2 saltwater rearing pens released anadromous salmon and trout at some time during this 14-yr period. The species of fish, brood year, number, weight and size of fish released, date of release, and release location are presented by rearing facility.

Russian LOS Volume Available on Loan

Oceans, Technology, and Law by M. I. Lazarev and L. V. Speranskaia (editors), U.S.S.R. Academy of Sciences, Institute of State and Law, International Law of the Sea Section, "Iuridecheskaia Literatura" Publishers, Moscow, 1972, describes and discusses the current international legal regime relating to the sea, and associated problems. It emphasizes problems of international straits and canals, territorial seas, the continental shelf, regulation of increasing use of the seabed, and regulation and protection of the living resources of the sea. Its thesis is that with expanded technological ability to utilize marine resources, increasing legal regulation of those resources is becoming necessary. The following three chapters from the translation will appear in "Ocean Development and International Law Journal," Crane-Russak Co., N.Y., N.Y.: Chapt. 7, "Scientific-technological progress and the search for legal regulation over possible uses of the ocean floor," by M. I. Lazarev; Chapt. 8, "Legal regulation of seabed uses beyond the limits of the continental shelf," by G. F. Kalinkin; and "International-legal regulation of marine fisheries," by A. A. Volkov. The translation, 141 pages, prepared for a private research group based in Washington, D.C., is available on loan from the Language Services Division, F43, Office of International Fisheries, National Marine Fisheries Service, NOAA, Washington, DC 20235.

Fishing Vessel Loan Booklet is Published

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) has published an information booklet of interest to commercial fishermen. **Fishing Vessel Obligation Guarantee** is 22 pages of most-asked questions, with detailed answers, concerning the NMFS program available to help fishermen get loans which finance or refinance up to 75 percent of the cost of constructing, reconstructing, or reconditioning commercial fishing vessels, at least 5 net tons or over, at reasonable interest rates and for periods of time commensurate with a fisherman's ability to repay.

This Department of Commerce booklet may be obtained free of charge from the Financial Assistance Division, National Marine Fisheries Service, NOAA, Washington, DC 20235, or from the Financial Assistance Officer at the NMFS Regional Offices in Seattle, Wash.; Terminal Island, Calif.; Gloucester, Mass.; St. Petersburg, Fla.; and Juneau, Alaska.

Recent Volumes Explore Marine Fisheries Law, Management, Mariculture

The American Society of International Law, a nonprofit scholarly Washington, D.C.-based organization, established a Working Group in June 1973 to explore living marine resource issues addressed by the U.S. Conference on the Law of the Sea. Papers by Working Group members constitute the bulk of **The Future of International Fisheries Management.** Authors are Lee G. Anderson, Robert M. Goldberg, Jon L. Jacobson, Douglas M. Johnson, H. Gary Knight, and Robert H. Neuman. Knight also served as editor. Published under USIL auspices, copies of the 253-page book are available from West Publishing Co., St. Paul, Minn. (price not listed).

The papers, in chapter form cover: (1) development of the law of the sea and international fisheries management; (2) implications of multinational investments for international living marine resource agreements; (3) criteria for maximum economic yield of an internationally exploited fishery; (4) future fishery technology and the third LOS conference; and (5) the role of enforcement in a global fisheries regime. The concluding section discusses an optimum global fisheries management policy.

"If aquaculture ever is to develop grand-scale proportions, it eventually becomes appropriate to consider conducting it in offshore waters," writes Joe A. Hanson, principal author and editor of **Open Sea Mariculture** (Dowden, Hutchison & Ross, Inc., Stroudsberg, Pa., $24.00). The 410-page book is the product of a NOAA Sea Grant to the Oceanic Foundation of Hawaii to study, from a systems engineering angle, the possibilities and problems in culturing marine organisms in the open seas. Besides Hanson, who authored or co-authored 10 of the 15 chapters, contributors include Edward D. Stroup, Steven V. Smith, Colin E. Nash, Carol C. Hanson, J. M. Collier, S. B. Ribakoff, G. N. Rothwell, and others. Editorial reviews were provided by Harvey Bullis, Carl Sindermann, Edward Klima, Terrence Nosho, Willis Clark, Ira Dyer, John P. Harville, and others.

Open sea mariculture is treated in four parts. Part I examines the bioeconomic, utilitarian (and historical), legal, and political perspectives while Part II covers geological and oceanographical aspects of the open sea environment. Science and Technology, Part III, treats nutrition, crop selection, environmental controls, necessary platforms, housing and energy, and handling and harvesting of crops. Part IV, Prospects for the Future, suggests a broad national mariculture research and development program. Each chapter has a list of references and the book is indexed.

Marine fisheries management has been mainly a matter of introducing restrictive regulations to minimize harmful effects of too much of the wrong kind of fishing says author J. A. Gulland in **The Management of Marine Fisheries**. However, he foresees a more strictly controllable, day-to-day policy of restricting the actual number of fish caught, their size, and where they are caught. Gulland is Chief, Fishery Statistics and Economic Data Branch, Fishery Economics and Institutions Division, FAO, Rome. His 198-page book is published by the University of Washington Press, Seattle, $16.50.

Gulland briefly reviews problems of fishery management in Chapter 1 while Chapter 2 uses the history of Antarctic whaling as an example of failure to manage and conserve a resource; the North Atlantic trawl fishery is discussed in Chapter 3. After examining the biological basis, the objectives, and the techniques of fishery management, the author discusses international implications and the future of marine fishery management. Author and subject indexes are provided as are references for each chapter.

Chum Salmon, Oil Spills, and Poisonous Crabs

. . . . Completion of the **first phase of a chum salmon imprinting (homing) study** to determine the feasibility of centralized incubation for rehabilitating salmon streams has been announced by the Alaska Department of Fish and Game. Some 125,206 fry were released in Disappearance Creek on Prince of Wales Island after being hatched and reared at the Deer Mountain Hatchery at Ketchikan. The eggs had been collected from Disappearance Creek in September 1974. Evaluation of early-returning salmon will begin in the fall of 1977 and continue in 1978 when the majority of returns are expected. . . .

. . . . **Equipment to control destructive oil spills** "still has a long way to go, especially where fast currents are involved," according to University of Michigan research engineers. In testing oil barriers, herders, and pickup devices the researchers found that at stream speeds over 1-mph, oil starts slipping underneath barriers and oil herding devices, while the U.S. Coast Guard wants something effective at 11-mph current speeds. They also found that most oil recovery (pickup) devices failed at current speeds over 5 mph. . . .

. . . . **Expansion of the boundaries of the Coastal Plains Regional Commission** to include 42 counties in eastern Virginia and 39 counties in northern Florida has been approved by the Secretary of Commerce, *The Marine Newsletter* reports. Previous boundaries included the 159 coastal plains counties of North Carolina, South Carolina, and Georgia. The expanded five-state region now comprises 240 contiguous counties with similar social, economic, geographical, and cultural characteristics. . . .

. . . . **William J. Hargis, Jr. has been designated Chairman** of the National Advisory Committee on Oceans and Atmosphere by President Gerald Ford, *The Marine Newsletter* reports. Hargis is Director, Virginia Institute of Marine Science and a biological oceanographer. . . .

. . . . **Florida's king mackerel tagging study has begun to yield results,** according to *Florida Conservation News*. About 700 fish had been tagged in January and February and three tagged in January were caught 9, 14, and 25 days after being tagged. Study data is being computerized by Atlantic Estuarine Fisheries Center, NMFS, NOAA, Beaufort, N.C. A rectangular "internal streamer tag" with a small length of plastic cord extending from its center, is being used. Tags are inserted ventrally; the cord is visible. Each returned tag carries a reward ranging from $1 to $25. . . .

. . . . North Carolina commercial fishermen caught **196 million pounds of salable fish and shellfish in 1974** for a total dockside value of $17.5 million according to *The Marine Newsletter*. This was a 65 million pound, $1.4 million increase over 1973. More than 42 species of finfish and six species of shellfish were included. Shrimp was most valuable as in 1973, at 8.4 million pounds (heads on) worth $4.6 million. The year 1974 was the state's best shrimp catch since 1955 and the best year ever for flounder at 12 million pounds. . . .

. . . . **A new species of poisonous crab, *Demania toxica*, from the Philippines** has been described by John S. Garth, University of Southern California, Los Angeles, according to a USC report. Screening for toxicity was done by A. C. Alcala, Silliman University, Dumaguete City, Negros Oriental, Philippines. The species has been found in areas where native food foragers hunt crabs and some human and domestic animal fatalities have been recorded. Reported occurrences are in the western Pacific, Garth points out. No poisonous crabs are known to occur along U.S. coasts. Research on the species and their toxicity continues . . . .

. . . . **Hugh L. Popenoe has been elected** chairman of the National Sea Grant Council for the year 1975-76. He is Director, Florida Sea Grant Program, and replaces Donald F. Squires of New York. The council is composed of the directors of the 26 Sea Grant programs. . . .

. . . . **Great Lakes commercial fishermen harvested over 125 million pounds** of fish in 1974, the highest total since 1967, *The Great Lakes News Letter* reports. Landed value was nearly $19 million, exceeding the peak years of the mid-1950's. A record alewife harvest and higher prices were the key factors according to data compiled by the NMFS and Ontario Ministry of Natural Resources. . . .

. . . . The Mississippi-Alabama Sea Grant Consortium reports it will host **the 8th annual meeting of the Sea Grant Association 27-30 October 1975** at the Sheraton of Biloxi Motor Inn, Biloxi, Miss. The 1975 theme is "Sea Grant: Putting it all Together." Further information is available from Joe Seward, Conference Coordinator, Mississippi-Alabama Sea Grant Consortium, P.O. Drawer AG, Ocean Springs, MS 39564 (601-875-9341). . . .

Errata

In the paper "Notes on the Ecology of the Oceanic Insect *Halobates*," by L. Cheng (*Marine Fisheries Review*, Vol. 36, No. 2), the symbols for *H. sericeus* and *H. germanus* were transposed in Figure 1, page 2.

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS STAFF
ROOM 450
1107 N.E. 45TH ST.
SEATTLE, WA 98105

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210

U.S.MAIL

MFR XEROX300XC R 1
XEROX UNIV MICROFILMS
SERIALS DEPT
300 N ZEEB RD
ANN ARBOR MI 48106

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

THIRD CLASS

76 AMERICA'S FIRST INDUSTRY